CUNNINGHAMIA

or 5 Leagues off Blackburn's Isle bearing N.N.E.
mande of his Majesty's Brig. Supply

VOLUME 1 (2)
1983

ROYAL BOTANIC GARDENS, SYDNEY

National Herbarium of New South Wales

CUNNINGHAMIA

ROYAL BOTANIC GARDENS, SYDNEY

Ecological contributions from the National Herbarium of New South Wales

Vol. 1 (2) 1983

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EDITED BY J.M. POWELL

Cover photograph: Profile of Lord Howe Island from NNE, drawn by Lieutenant Henry Lidgbird Ball in February 1788. This profile is in the log of H.M. Brig "Supply".

VEGETATION OF LORD HOWE ISLAND

John Pickard

(Accepted for publication 8.7.1981)

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ABSTRACT

Pickard, John (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, New South Wales, Australia 2000) 1983. Vegetation of Lord Howe Island. Cunninghamia 1(2): 133–265.* Lord Howe Island (31°30′S, 159°05′E) is a 1520 ha oceanic island. Some 80% is basaltic, the remainder is calcarenite derived from the coral reef on the west side of the island. There are four physiographic regions: northern hills rising to 209 m, central hills rising to 121 m, central lowlands of calcarenite, and southern mountains rising to 875 m and occupying about 55% of the island. Rainfall is 1676 mm with a marked maximum in July-August. Diurnal and seasonal variation in wind speed and direction occurs; the annual mean is c. 5.5 km/h. Mean annual temperature is 19.1°C.

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The island was discovered in 1788 and settled in 1833. It is part of New South Wales and is administered by the Lord Howe Island Board. Despite continuous occupation for almost 150 years, less than 20% of the island is disturbed and less than 10% cleared.

Twenty-five associations in 20 alliances and 14 subformations are mapped at 1:15,840, and described using a novel tabular format. A key to associations is presented. About 57% of the island supports monotypic forests of six species, four of them endemic. Scrub, grass and herbland covers the rest. Marked physical and chemical differences between basalt and calcarenite are difficult to detect in the vegetation except locally. Salt spray driven by almost constant on-shore winds appears to be a major determinant of vegetation distribution. One million pairs of seabirds nest on the island but are in equilibrium with the vegetation. Individual plants in the nesting areas show different responses to the birds, but the communities are unaffected. Five introduced mammals (goats, pigs, rats, cattle and man) have greatly altered the vegetation locally. The most important are cattle and man. Cattle grazing prevents regeneration of native plants and encourages the spread of vigorous introduced pasture grasses. Disturbance by man has been episodic according to the economic conditions prevailing. A feature is a series of abandoned gardens of different ages scattered through the northern section of the island. These show old-field succession and the effects of different combinations of limiting factors leading to steady states. Cattle are particularly important in maintaining some of these. Palm-seeding has little long-term effect on the *Howea* forests but the industry should move to plantations and nurseries for seeds and seedlings for export. The settled areas of the island are continually disturbed to presumably improve the aesthetic appearance. Recently some areas have been replanted with native species to replace the previously destroyed vegetation. Despite recommendations for conservation, little has been done.

INTRODUCTION

Lord Howe Island (31°30′S, 159°05′E) is a small oceanic island in the South Pacific Ocean some 600 km east of Australia. The island is crescent-shaped, about 10 km long and from 0.3 to 6 km wide. A coral reef about 5 km long on the western side of the island is the most southerly in the world. Most of the 1520 ha of the island is basaltic but about 20 per cent is calcarenite derived from coral sand. Two mountains occupy about half of the island in the south and rise to 875 m. Several small islets occur offshore within 3 km of Lord Howe.

The island was first sighted in 1788 and has been settled since 1833. There is no archaeological evidence of earlier inhabitants. Today, about 250 permanent residents work in the tourist industry or provide services such as radio communications, weather observations, civil aviation and local government. Some 4000 tourists visit the island each year. The island is politically part of New South Wales and is administered by the Lord Howe Island Board. The Board is comparable to a municipal council, although many of the members are government appointees. Day-to-day management is by the Island Superintendent, an employee of the Board, and his staff.

Despite its long settlement, Lord Howe has largely escaped the fate of many small isolated islands. Less than 20 per cent of its vegetation is disturbed and less than 10 per cent cleared. Most of the island is heavily forested although scrub and grassland occurs on the more exposed areas and offshore islets. About 57 per cent of the island supports monotypic stands of six tree species, four of them endemic. Two, *Howea forsterana* and *H. belmoreana* are well known throughout the world as cultivated palms. Much of the flora of 400 species has affinities with New Zealand and the Pacific. About 30 per cent of the flora is introduced, and of the native species, 30 per cent are endemic.

Feral animals are present (rats, goats, pigs and cats) with variable consequences to the biota. Several birds are now extinct, but so far as is known, no plants. The pressure of goat browsing on the rich endemic flora of the southern mountains prompted Mr Peter S. Green of the Royal Botanic Gardens, Kew to urge the New South Wales Government to undertake an environmental survey of the island. The Government agreed and the survey, co-ordinated by Dr Harry F. Recher of The Australian Museum, Sydney, commenced in 1970.

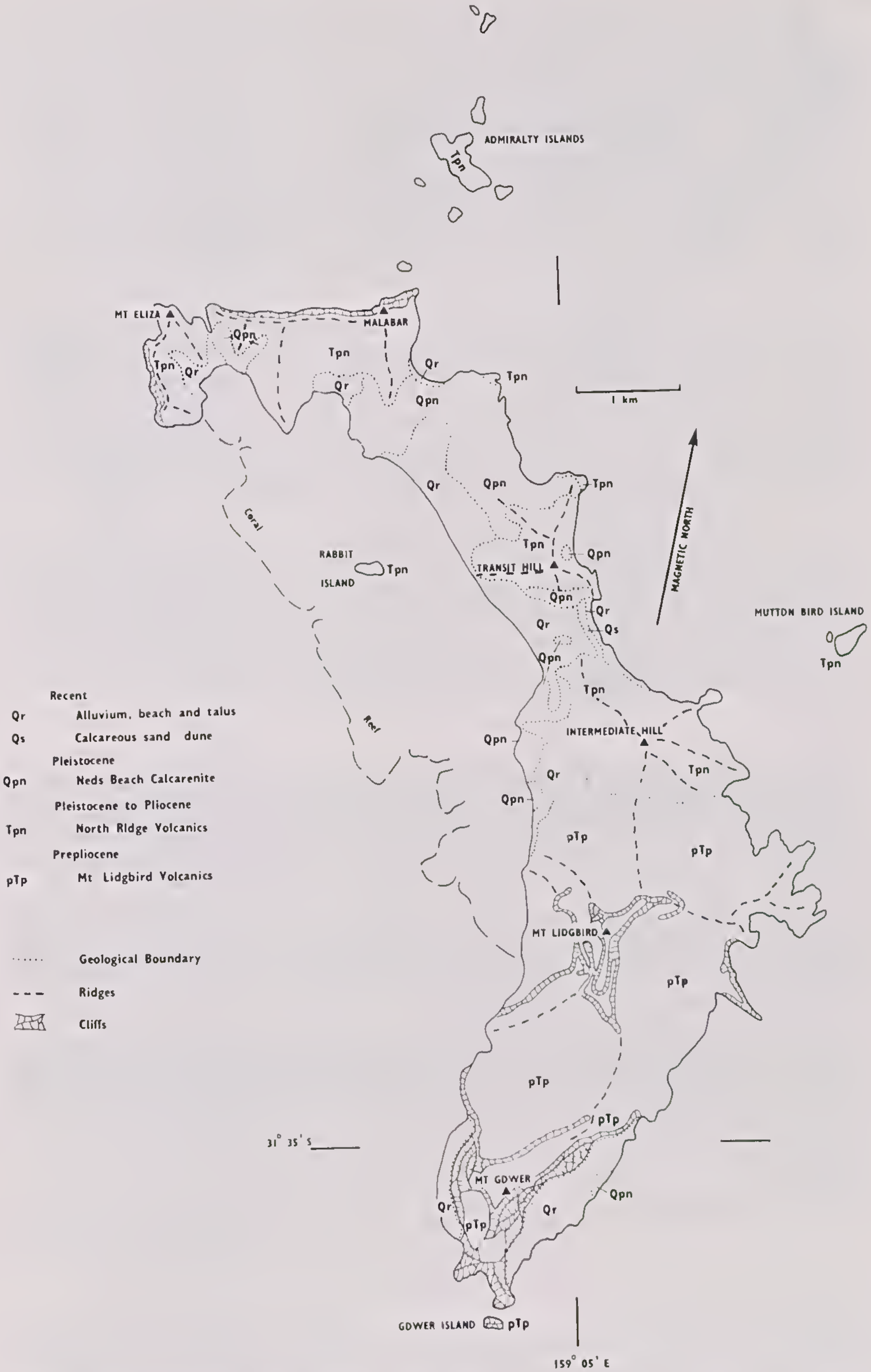

Figure 1. Geological map. Source: modified after Standard (1963) and Sutherland & Ritchie (1974).

The aim of the Environmental Survey was to describe the ecosystems of Lord Howe Island and to provide biological information for the assessment of future management options (Recher & Clark, 1974). As the vegetation is of great intrinsic interest and is a major determinant of faunal distribution, the National Herbarium of New South Wales decided to undertake a survey of the vegetation. I commenced the survey in 1970 and continued with field work after the immediate requirements of the Environmental Survey were completed in 1974 (Pickard, 1974). The aims of the vegetation survey were broadened beyond describing the vegetation and preparing a vegetation map, to include testing different methods of data collection and analysis. This paper presents descriptions of the vegetation based on a subjective classical approach. A projected second paper describes the objective approach using numerical analysis of floristic and structural data (Pickard, 1978).

Other aspects of the study which are discussed here include the influence of geology, climate, fauna and settlement on the vegetation. Information gained during a survey of the palm seed industry, keys to the vegetation, a handbook of the ferns, data and discussion on the distribution of angiosperms, on plant invasions and extinctions, on the origins of the flora and on the effects of feral animals will be published elsewhere (Pickard, 1980; unpublished data). Similarly, detailed descriptions of the vegetation of the offshore islands, Mount Gower and Little Slope will be presented elsewhere (Pickard 1976, 1978, unpublished data).

The nomenclature of the vascular plants follows current practice at the National Herbarium of New South Wales (Jacobs & Pickard, 1981), where my extensive voucher collection is lodged. Authorities for most angiosperms are given by Rodd (1974) although his list is now incomplete. Authorities for ferns are listed by Pickard (unpublished data)*. Nomenclature of place names follows Pickard (unpublished data); the place names used are not necessarily approved geographical place names under the Geographic Names Act of New South Wales.

Geology

Lord Howe Island is a small erosional remnant of the Lord Howe Volcano situated on the western edge of the Lord Howe Rise in the Tasman Sea. A series of volcanic eruptions, followed by extensive erosion, began about 30 million years ago and another period of volcanic activity occurred during the Miocene (about 10 million years ago); subsequent erosion has reduced the volcano from about 1200 m to its present height of 875 m. The older volcanics outcrop in the northern and central hills and the northern offshore islands, whereas the younger volcanics form the southern mountains, according to recent studies (Game, 1970; Sutherland & Ritchie, 1974). This contrasts with an earlier opinion (Standard, 1963) that the Lidgbird (southern) volcanics are older (Figure 1).

Sediments of Pleistocene or younger age occur on low-lying, flat land between the hills. Aeolian calcarenite, formed from wind-blown coral sand, was deposited in several stages during the Pleistocene. Elsewhere, recent alluvium or talus deposits occur (Standard, 1963).

Physiography

The physiography of the island mirrors the geological background. Four main

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*Since this paper was accepted for publication, a number of names have changed, for example, *Howea forsterana* is now *H. forsteriana,* and *Drypetes australasica* is now *D. lasiogyna* var. *australasica.* For logistic reasons, these remain unaltered here. The current (1983) names of both angiosperms and ferns are listed by Rodd & Pickard (this issue).

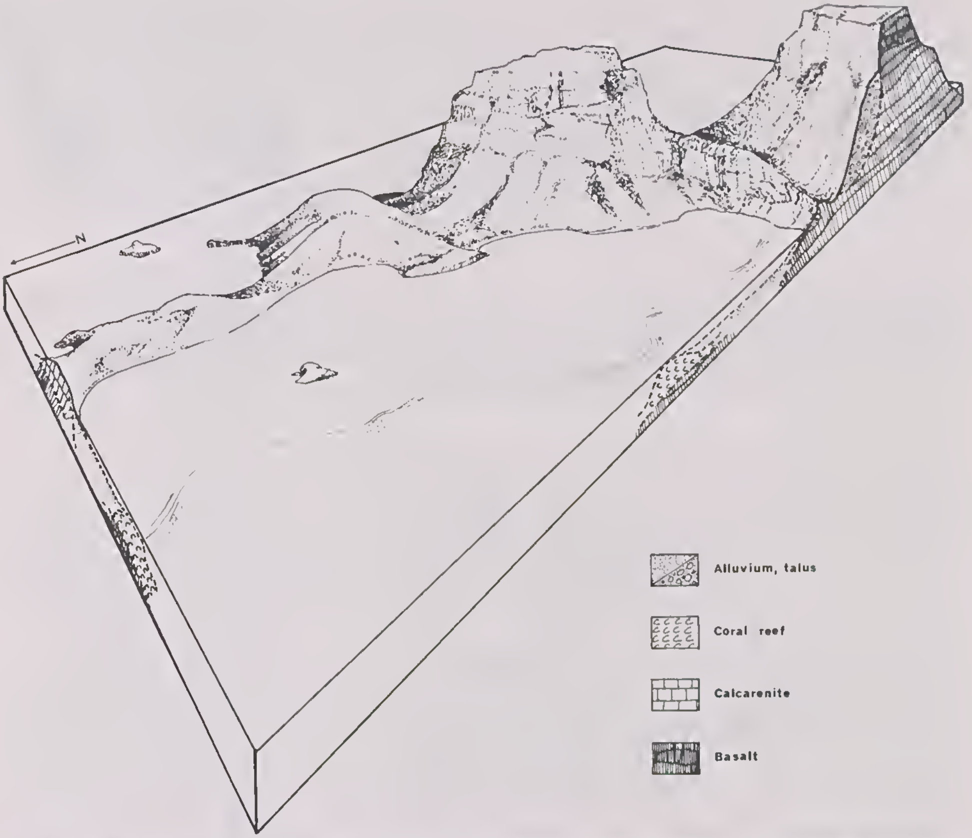

Figure 2. Block diagram of the southern end of Lord Howe Island. Mount Gower on the right is separated from Mount Lidgbird by Erskine Valley. Smoking Tree Saddle, north of Mount Lidgbird marks the beginning of the central hills. Intermediate Hill is the dome, with Mutton Bird Point and Mutton Bird Island to the north. Flat ground at Mosely Park continues around the base of Transit Hill. Rabbit Island sits in the lagoon behind the shelter of the coral reef.

patterns can be distinguished: southern mountains, calcarenite slopes and alluvial flats, and northern and central hills (Figures 2, 3, 4; Etheridge, 1889b; Standard, 1963).

The southern mountains (Figure 2) run south from Smoking Tree Saddle; steep slopes and basalt cliffs rise to 850 m and include Mount Lidgbird (777 m) and Mount Gower (875 m). The summit of Mount Gower is a plateau falling from east to west down a series of small cliffs separated by gently to steeply sloping benches. A number of subparallel semi-permanent creeks drain the plateau and fall over the cliffs on the western edge of the summit. Cliffs form the edge of the plateau on all sides except the north and the south; below them debris avalanche slopes run down to sea level. In the north, a narrow ridge runs down to The Saddle and then up to Mount Lidgbird. In the south, a steep spine (Razorback) drops sharply for 300 m before plunging 600 m down cliffs into the sea.

Unlike Mount Gower, Mount Lidgbird is a narrow ridge above several tiers of cliffs. The slopes below the cliffs are uniformly bouldery. Several large landslides have fallen from the tiers of cliffs in the last 20 years. The two mountains are separated by Erskine Valley which runs west from the Saddle down to sea level. On the eastern foot of Mount Lidgbird a series of bouldery slopes cut by creeks, basalt outcrops and landslides, known as Fern Patches, run down to broken cliffs above the sea.

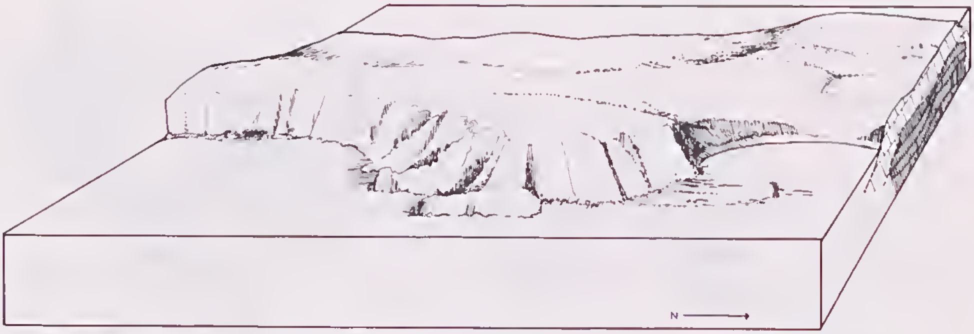

Figure 3. Block diagram of the calcarenite ridge looking west over Jims Point. Highly porous calcarenite underlies the gentle slopes which have no external surface drainage. The east coast has cliffs with sandy beaches such as Neds Beach on the right.

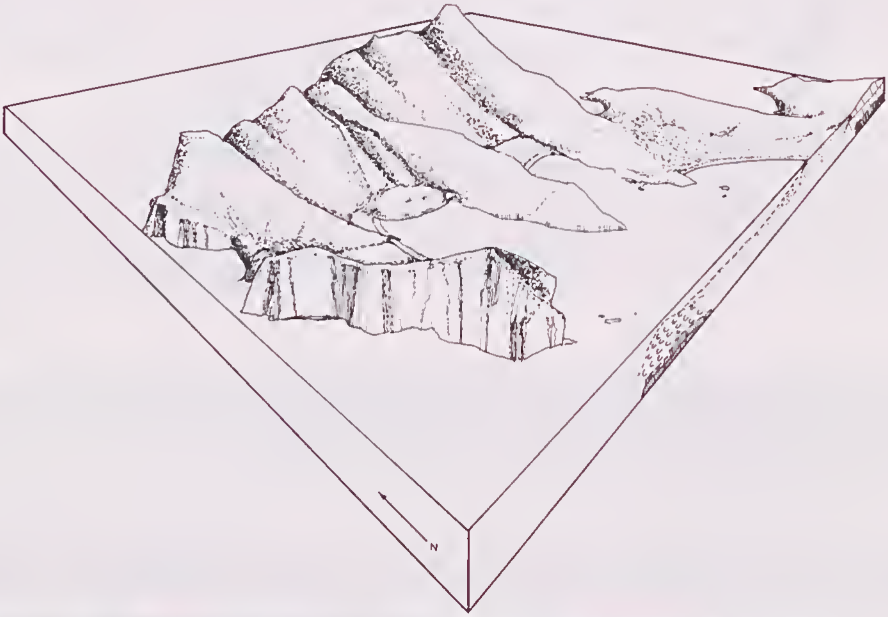

Figure 4. Block diagram of the northern hills looking east towards Malabar. On the right the calcarenite ridge runs gently down to Lagoon Beach. Malabar Ridge and Dawsons Point Ridge rise to an undulating east-west ridge in the north. Steep cliffs fall from this ridge into the sea. Old Settlement Beach is behind Dawsons Point Ridge. Mount Eliza is isolated by Old Gulch (hidden) and New Gulch, low-lying areas behind North Beach. In the foreground, cliffs fall into the sea from the ridge running south to Phillip Point (North Head).

Far Flats, another boulder slope, runs down from the cliffs on the west. The northern slopes of Mount Lidgbird fan out radially from Salmon and King Beaches on the west, over Smoking Tree Saddle to the jagged sea cliffs from Edmanoch Point to Sugarloaf Point. All these slopes are steep and bouldery in their upper sections but less so near sea level.

The central hills (Figure 2) are gently rounded basalt hills between Smoking Tree Saddle in the south and Neds Beach in the north. Intermediate Hill (250 m), situated between Smoking Tree Saddle and the alluvial flats of Moseley, is dome-shaped, with rounded ridges and concave sides. Drainage from the hill is essentially radial and few of the streams are perennial. Although most of the ridges are rocky, several benches with impeded drainage occur on the western side of the summit. Landslides are not common, but one fell near the crest of the main north-south ridge and flowed down the western slopes in 1977. Cliffs form the eastern foot of the slopes but these rarely exceed 30 m. Mutton Bird Point, which projects from these cliffs, is almost detached and only a narrow spine of eroding basalt ties it to the island. In the west, the ridges and spurs run out onto more gentle slopes terminating above calcarenite cliffs on the lagoon.

Transit Hill (121 m) is essentially a smaller and simpler version of Intermediate Hill. It is more complex geologically as there are two calcarenite deposits on its flanks. One, Little Mutton Bird Ground, covers about 0.7 ha and occurs on the eastern side above basalt cliffs about 40 m high, while the other, of about 10 ha, lies in the catchment of Edies Glen, northwest of the summit.

North of Transit Hill, the basalt splits into two tongues, one heading northeast to Brodies Point, the other through Middle Beach Common before disappearing under calcarenite behind the school. Between these tongues lie Valley Garden and Valley of the Shadows. Valley Garden is a circular solution depression in the calcarenite close to its junction with the basalt, while Valley of the Shadows is an elongate depression with little external surface drainage except on the north.

The main ridge continues north towards Neds Beach as a broad, round and gentle calcarenite rise which is a major part of the third physiographic pattern (Figure 3). There are few distinct spurs. With the exception of basalt outcrops near Stevens Point, the eastern margin is a series of low calcarenite cliffs. In the west, the ridge slopes down into broad flats of alluvium and sand which run behind Lagoon Beach. These flats run the full length of the beach except near Windy Point where a spur from Transit Hill terminates in a low abrupt point. Thre are no surface streams. Several sections of the flats are swampy but most appear well-drained. Along the western foot of Intermediate Hill, there are some calcarenite slopes and low cliffs. The very swampy and flood-prone alluvial flats of Soldier or Big Creek are included in this pattern. Old Settlement Beach marks the northern limit of the flats. Here a small calcareous sand dune, about 2 m high, occurs between the beach and the swamps of Old Settlement Creek. A similar low dune occurs along the full length of Lagoon Beach but the dune at Blinky Beach, on the eastern side of the island, is about 10 m high.

The northern hills (Figure 4) rise abruptly from the flats as parallel ridges separating steep, bouldery creeks. These ridges rise to a major east-west ridge at 160 m elevation. This ridge is asymmetric and the cliffs on the northern side form the northern edge of the island. The highest point, Malabar (209 m), occurs at the eastern end, at the junction with Malabar Ridge, which runs south down to the flats. Further east, Dawsons Point Ridge runs south from Kims Lookout to Dawsons Point in the lagoon. Unlike the steep, narrow Malabar Ridge, this is rather gentle and wide. The sides of both are steep and very bouldery.

Mount Eliza (147 m) dominates the area behind North Beach. Its southern ridge is steep and markedly convex but north from the summit, it falls down cliffs to Phillip Bluff (Fishy Point). Mount Eliza is isolated from ridges on both sides by Old Gulch on the east and New Gulch on the west. These are bays eroded into the coastline but also low points on the island. Between North Beach and Old Gulch, the maximum altitude is only about 12 m. Alluvium extends most of the way from North Beach to Old Gulch but only half way to New Gulch. Here a broad valley separates Mount Eliza from the ridge marking the western edge of the northern hills. Like the other ridges, this runs north-south, and like the major northern ridge, it terminates in cliffs.

TABLE 1

Chemical analyses of basalt, calcarenite and soil, expressed as percentages of calcium oxide and phosphorus pentoxide.

		CaO%	P_2O_5%
Basalt: all analyses	(n = 14)	8.2	0.43
Lava	(n = 9)	7.7	0.51
Dykes	(n = 5)	9.0	0.38
Calcarenite:	(n = 4)	52.3	trace
Soil (Parent material not known)	(n = 5)	no data	6.24

Sources: Game (1970), Wilkinson (1882).

Offshore islets occur at various distances from Lord Howe. All are basaltic and surrounded by cliffs up to 50 m high. The summits are usually rounded with many rock outcrops. Pockets of soil are mostly shallow but on Roach and Mutton Bird they are somewhat deeper. The main group, the Admiralty Islands, lie north of Lord Howe and include seven islets of different sizes. The largest, Roach Island, of about 16 ha rises to 86 m. Mutton Bird Island and Sail Rock are 1.2 km off Mutton Bird Point. Gower Island, 120 m off the southern tip of Lord Howe, has a flat summit at 30 m height. Rabbit Island is within the lagoon, about 800 m off Windy Point. The basalt spire of Balls Pyramid juts 550 m out of the sea some 19 km southeast of Lord Howe.

Soils

The soils on the island have not been studied in any detail. Past observations have been sparse and restricted to brief descriptions of wells and a few chemical analyses (Table 1). During the present study very few observations were made.

There are marked physical and chemical differences between the two major substrates, calcarenite and basalt, which are reflected in the soils (Table 1). Soils on calcarenite are coarse sands, on basalts they are clays. Between 1970 and 1973 the New South Wales Department of Public Works drilled over 100 holes for airstrip investigations. A typical core is:

0 – 1.5 m	Sand and coral
1.5 – 4.0 m	Volcanic ash, coral, silt and sand
7.0 –10.0 m	Coral
10.0 – m	Volcanic ash, fines, silt and sand.

It is unfortunate that no detailed studies have been made on these cores. The log above apparently indicates two periods of volcanic activity separated by a marine transgression (if the coral is correctly identified and is not calcarenite).

Soil profiles, classified as Uc 1 (Northcote, 1971), were examined on calcareous beach sand at North Beach and elsewhere. Very few profiles were examined on basalt because of the stony nature of the soil. Stones from 20 to 200 mm diameter and larger are very common and can occupy up to 20 per cent of the volume of basaltic soils. The interstitial matrix is generally clay textured and appears to be Uf 3.4 (Northcote, 1971) i.e. uniform, fine-textured soil.

TABLE 2

Selected climatic elements recorded on Lord Howe Island

Element	Variable	Format	Period (Years)	Figure*	Source**
Rainfall	Raindays	Monthly	10 & 15	6	Gentilli 1971
	Rainfall	Hourly	5 (1967-1972)	7	
		Monthly	46	8	Anon. 1969
			70 (1886-1967)	8	
		Annual	70 (1886-1967)	9	
Wind	Speed 0900 h	Monthly	4		Gentilli 1971
	1500 h	Monthly	4		Gentilli 1971
	Speed & direction				
	frequency 0900 h	Monthly	7 (1965-1971)	10	
	1500 h	Monthly	7 (1965-1971)	10	
	Maximum gust				
	Speed	Annual	23 (1940-1963)	—	Whittingham 1964
	Direction	Annual	23 (1940-1963)	—	Whittingham 1964
Cloud	Cloud 0900 h	Monthly	10	12	
	1500 h	Monthly	10	12	
Temperature	Temperature	Monthly	27	13	Anon. 1969, Gentilli 1971
Relative Humidity	Daily Index	Monthly	28	14	Anon. 1969
	Relative Humidity				
	0900 h	Monthly	28	14	Anon. 1969, Gentilli 1971
	1500 h	Monthly	9	14	Gentilli 1971

* Refers to the figure where the data are graphed.

**Where no source is given the data are unpublished Bureau of Meteorology records.

The following profile is developed on the summit plateau of Mount Gower:

0 – 7.5 cm	Litter and decomposing organic material, colour 5YR2/2*, pH 5.5.
7.5 – 15.0 cm	Plastic clay, colour 7.5YR3/2, pH 6.0.
15.0 – 17.5 cm	Mottled grey clay, 2.5YR3/0 matrix with mottles of 7.5YR3/2, pH 6.0. Sharp boundary.
17.5 –150.0 cm	Decomposed rock, reddish with yellow mottles around hard "core stones" c. 5 mm diameter, pH 6.5.

The soil profiles (0 -17.5 cm) was very soft with a high moisture content. The grey clay band at 15-17.5 cm appeared to be a gley horizon.

Climate

Climatic data have been recorded at the Meteorological Station for varying periods up to 70 years (Table 2). The Meteorological Station is situated on the low ridge between Transit Hill and Neds Beach above Middle Beach. It is exposed to the

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*Munsell colour charts used for colour determinations.

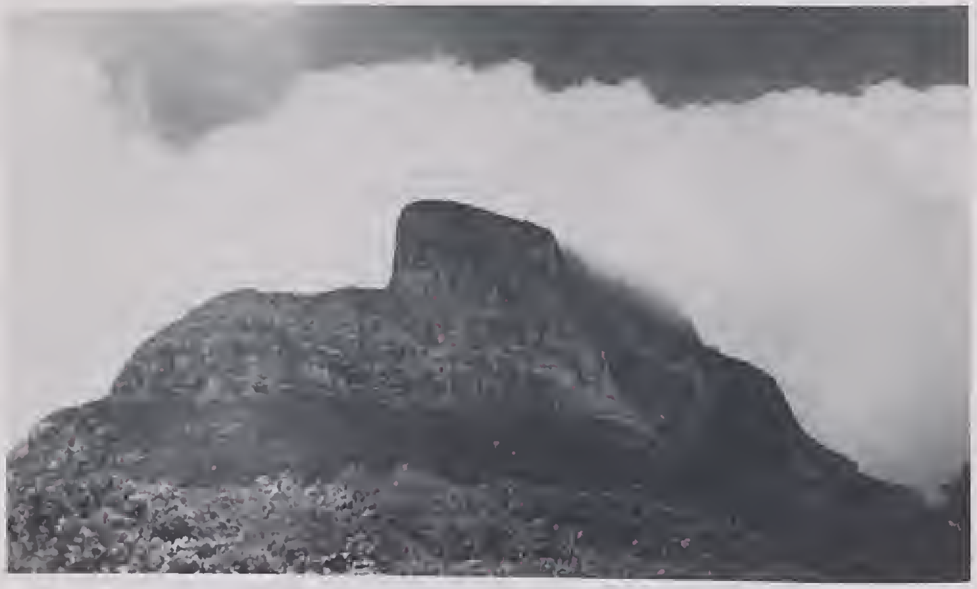

Figure 5. Heavy orographic cloud on Mount Lidgbird bringing very intense rain to the southern mountains. Looking south from Boat Harbour.

southwest. Winds from the NNW and E-SSE are unreliable and of extreme gustiness (Whittingham, 1964). Data from the Meteorologial Station are unrepresentative of the climate at the southern end of the island. Here the mountains generate orographic cloud (Figure 5), modify wind patterns and consequently greatly alter the climatic regime.

Records of climatic variables are not all available for comparable periods (Table 2). Only those variables likely to affect vegetation are considered here. Unpublished data are available from the Bureau of Meteorology for rainfall (daily), low cloud 0900 and 1500h (monthly), all types of cloud (monthly), thunder, cloudy and clear days (monthly), dew (monthly), wind speed and direction frequency (daily and nightly), wind maximum gust speed, direction and time of occurrence (daily) and wind maximum gust month of occurrence (annual). Frost, fog and snow have never been observed on the island. Evaporation and solar radiation are not recorded.

Regardless of the original units, I express all measurements in SI units in the discussion. On diagrams both SI and imperial units are shown where appropriate. All times are expressed as Lord Howe Island time which is Greenwich Mean Time plus 10 h 30 min, and Australian Eastern Standard Time plus 30 min.

Correlations between some variables were calculated using monthly means (Table 3). On *a priori* grounds some significant correlations can be expected: evaporation with temperature and precipitation (as these are used to calculate evaporation); raindays with temperature, evaporation, precipitation, thunder days, wind speed and temperature; wind speed with evaporation and thunderdays. Some of the significant correlations are probably due to mutual associations with one or more other variables. For example, partial correlation coefficients reveal that the correlation between wind speed 0900 h and evaporation ($r = -0.751$, $p<0.01$) is largely due to the correlation between wind and temperature ($r = -0.850$, $p<0.001$). The correlation between wind speed 0900 h and evaporation, free from the mutual association of temperature with both, is $r = -0.190$ (n.s.).

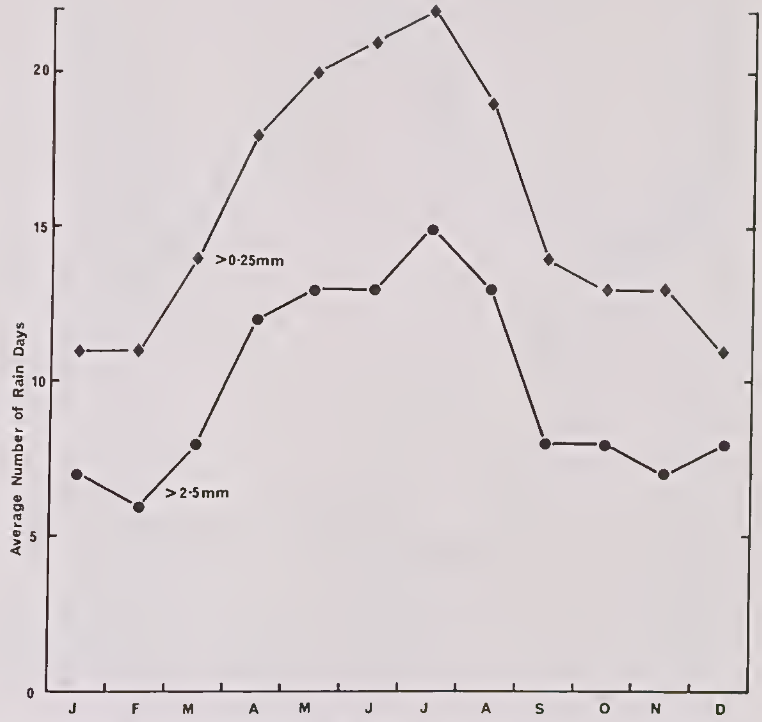

Figure 6. Mean monthly number of raindays. Raindays are defined as days with more than 0. 25 mm (◆) and more than 2.5 mm(●) recorded rain.
Source: Gentilli (1971) ◆ 15 years, ● 10 years

TABLE 3

Correlation matrix of mean monthly climatic data

	Fig.†	1	2	3	4	5	6	7	8
1 Mean minimum temperature	13								
2 Mean wind speed 0900 h	10	-0.850 ***							
3 Mean wind speed 1500 h	10	-0.813 ***	0.853 ***						
4 Evaporation	13	0.815 **	-0.751 **	-0.680 *					
5 Mean monthly raindays (>0.25 mm)	6	-0.703 *	0.676 *	0.628 *	-0.942 ***				
6 Mean monthly raindays (>2.5 mm)	6	-0.675 *	0.635 *	0.605 *	-0.883 ***	0.971 ***			
7 Mean monthly rainfall	8	-0.558	0.516	0.422	-0.801 **	0.886 ***	0.876 ***		
8 Mean monthly cloud cover 0900 h	12	0.634 *	-0.639 *	-0.497	0.367	-0.310	0.400	-0.153	
9 Mean monthly cloud cover 1500 h	12	0.240	-0.181	-0.227	-0.259	0.389	0.398	0.519	0.511

†Figure: Refers to the figure where the data are graphed.
Significance level: blank not significant; * p⩽ 0.05; ** p⩽ 0.01; *** p⩽ 0.001.

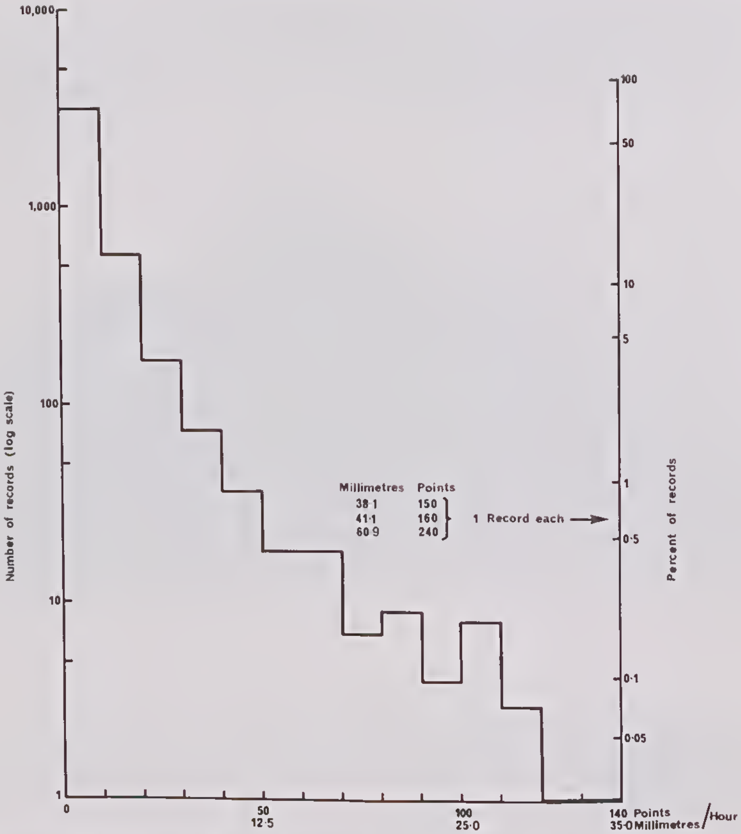

Figure 7. Frequency histogram of hourly rainfall.
Source: Bureau of Meteorology unpublished data, July 1967-July 1972.

Rainfall

Gentilli (1971) provides data for mean monthly number of days with falls of rain exceeding 0.25 mm and 2.5 mm (Figure 6). The average number of raindays per month doubles from about 11 in summer to 22 in winter. This seasonal pattern is similar to that of monthly precipitation (Figure 8). Sixty to seventy per cent of rain days account for 90 per cent of the rainfall.

The hourly intensity of rainfall is extremely skewed (Figure 7) with fewer than 1 per cent of the recorded falls exceeding 12.7 mm and fewer than 0.2 per cent exceeding 25.4 mm. There are rare intense falls, for example, in the 4 029 rain hours represented in Figure 7 there is one fall each of 38.1, 50.5 and 61.0 mm. These falls greatly influence soil, and hence vegetation, instability. Landslides are extremely likely following such falls of rain. Hourly intensity can vary considerably over a short time span. For example, on 15.4.1968 there was a fall of 37.5 mm in one hour with no rain in the immediately preceding or following hours. At the other extreme are long periods with no precipitation: between July 1967 and July 1972, the 4 029 hours of rain recorded are less than 10 per cent of the total number of hours. The most common pattern is a period of several hours light rain giving a substantial total fall. There is marked seasonality of precipitation (Figure 8) with a peak in winter and a low in summer. Both sets of monthly data (for 46 and 70 years) show the seasonal pattern, but as could be expected, the 70 year curve is the smoother. Evaporation, calculated using Fitzpatrick's (1963) method, exceeds precipitation in summer (December-February). Total annual precipitation is variable between extremes of 2870 mm in

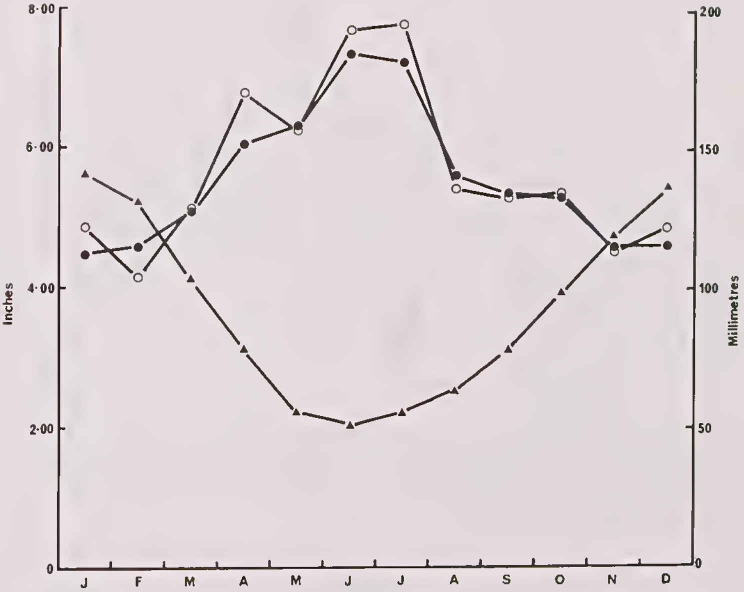

Figure 8. Mean monthly rainfall (46 year mean ○, 70 year mean ●) and estimated evaporation.
Source: 46 year rainfall (○) Anon. 1969.
70 year rainfall (●) Bureau of Meteorology, unpublished data, 1886-1967. Evaporation (▲) based on temperature and rainfall data in Anon. (1969).

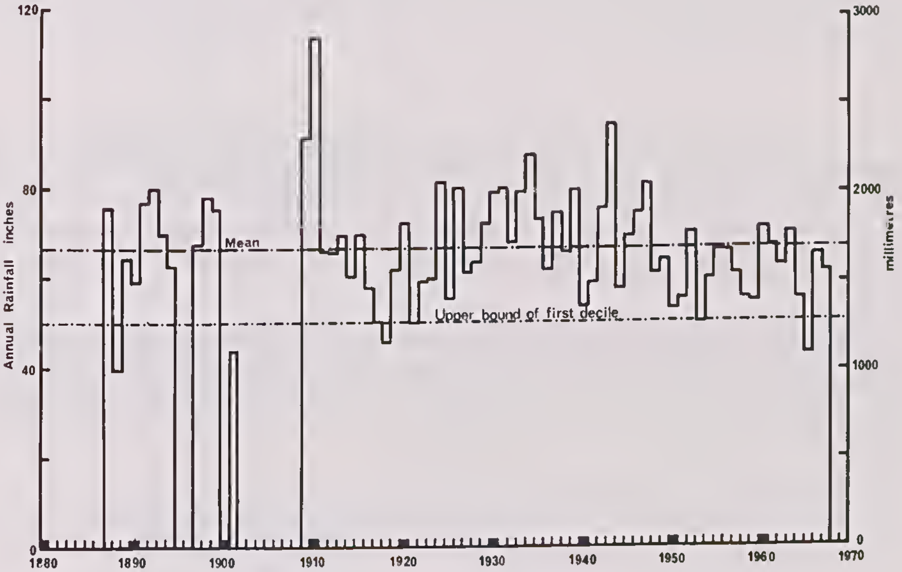

Figure 9. Annual rainfall. See text for explanation of first decile.
Source: Bureau of Meteorology unpublished data, 1886-1967.
Records for 1895, 1896, 1900, 1902-1908 are missing or incomplete.

1910 and 1000 mm in 1888 (Figure 9). The median of 1655 mm is very close to the mean (1676 mm).

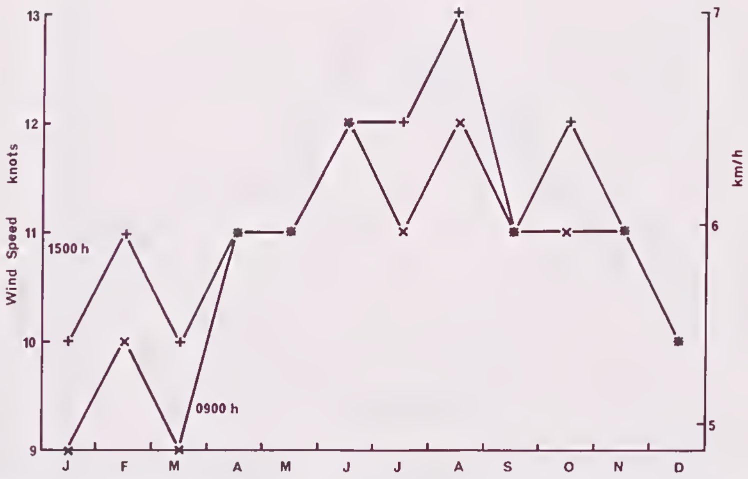

Figure 10. Mean monthly 0900 (×) and 1500 (+) h wind speed. Sources: Bureau of Meteorology unpublished data, Gentilli (1971) 4 years.

Although none of the usual definitions of drought is particularly relevant to natural vegetation, the first decile definition of Gibbs & Maher (1967) appears to be the most appropriate. They define a drought year as one whose rainfall lies in the lowest 10 per cent of the total years accounted for. Thus, on Lord Howe Island, over the 70 years considered, the 7 years (10 per cent of 70) of drought were 1887, 1901, 1917, 1918, 1921, 1953 and 1965 (Figure 9). All seven had an annual precipitation of less than 1270 mm.

Wind

Mean monthly wind speed varies both diurnally and seasonally (Figure 10). The afternoon (1500 h) winds are always stronger than the morning (0900 h) winds. The seasonal trends in wind speed for both morning and afternoon are broadly similar ($r = 0.853$, $p < 0.001$). Mean speed increases from summer through autumn to a maximum in winter then decreases through spring to a minimum in summer. The uneveness in the data (Figure 10) is a consequence of the short record (Table 2).

A more informative examination of the wind is provided by calculation of onshore wind resultants using only vectors for the three onshore directions at the particular aspect (Figure 11). Thus, for the north aspect, only winds from the northwest, north and northeast are used. Following the method of Landsberg and Bagnold described by Jennings (1957) the vectors are calculated as:

$$b = 10^{-3} \sum_{j=3}^{12} n_j (v_j - V_t)^3$$

where b = length of the individual vector for the direction under consideration

n_j = % frequency of wind of Beaufort speed class j in the direction

v_j = mean speed in miles/h of the Beaufort speed class j

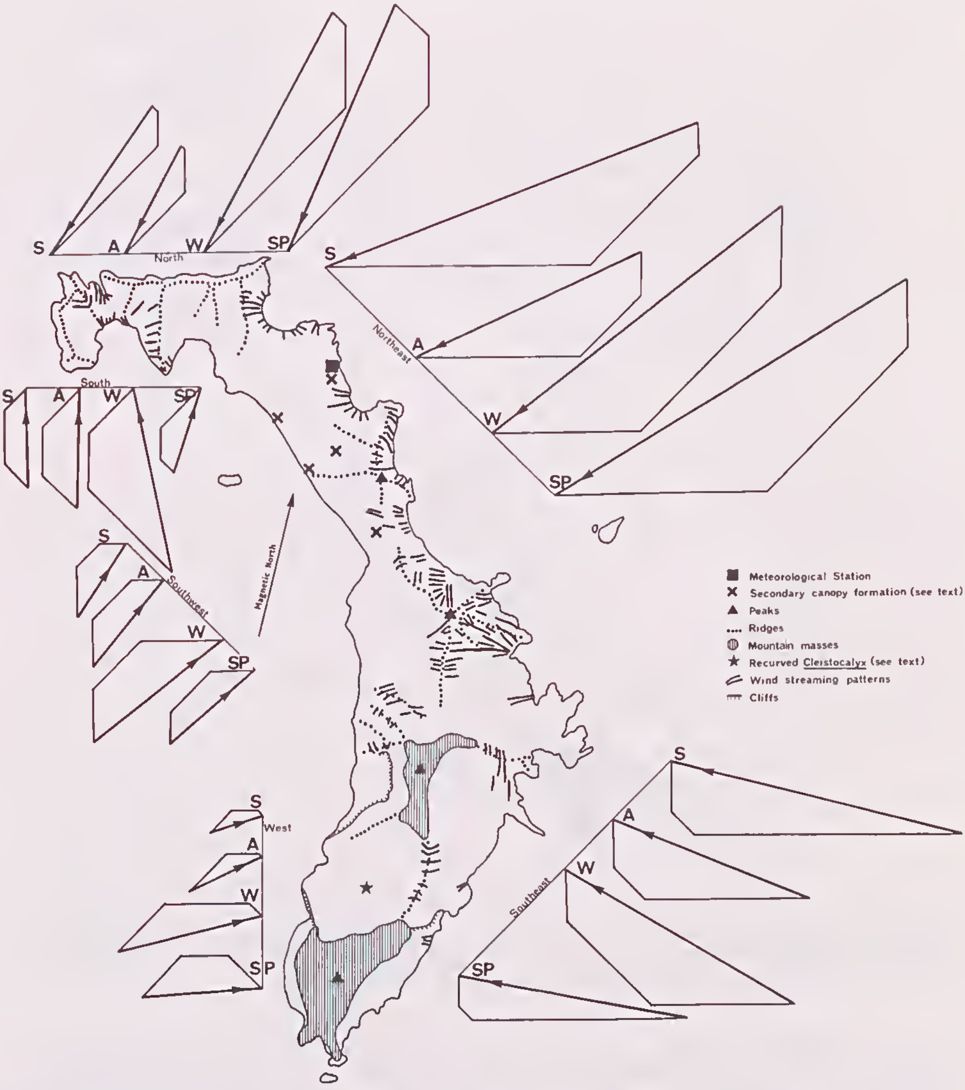

Figure 11A. Onshore wind resultants for 0900 h for six aspects and each season. S = Summer (Dec, Jan, Feb), A = Autumn (Mar, Apr, May), W = Winter (June, July, Aug), SP = Spring (Sept, Oct, Nov). Source: Bureau of Meteorology unpublished data, 1965-1971.

The constant V_t = 10 miles/h [16 km/hr] (corresponding to 3 on the Beaufort scale) is assumed to be the threshold wind speed for sand drift, and is retained here as very low speed winds probably have little or no effect on the vegetation.

The striking feature of the onshore resultants is the dominance of winds from the southeast and northeast (Figure 11). The magnitude of the resultants changes seasonally with the afternoon winds more variable than the morning winds. Changes in direction are slight throughout the year.

Annual maximum wind gust data for 1940–1962 are presented by Whittingham (1964). As there are only 23 observations, only the gross features will be considered.

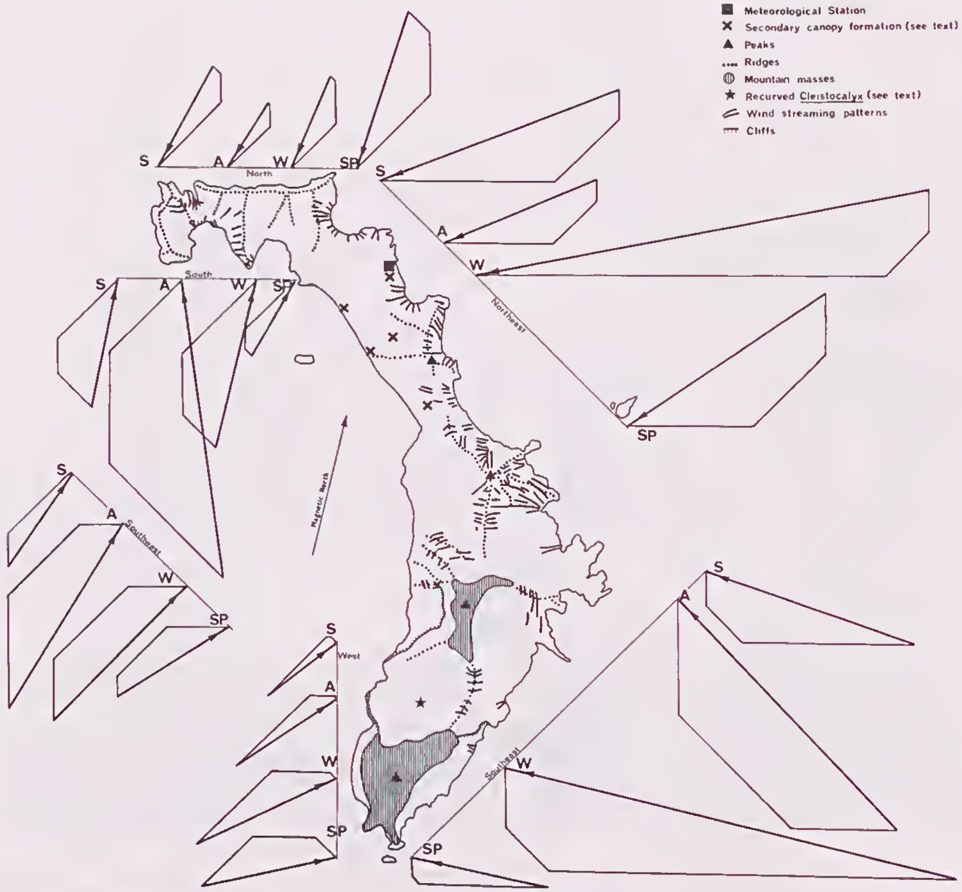

Figure 11B. Onshore wind resultants for 1500 h for six aspects and each season. S = Summer (Dec, Jan, Feb), A = Autumn (Mar, Apr, May), W = Winter (June, July, Aug), SP = Spring (Sept, Oct, Nov). Source: Bureau of Meteorology unpublished data, 1965-1971.

The mean is 125 km/h and the range is relatively small; the strongest recorded was 178 km/h in 1948 and the weakest 89 km/h in 1962. The monthly distribution is seasonal with maxima in autumn-winter and minima in summer. Maximum gusts have occurred from all directions but there is a slight trend towards northerly dominance. The maximum gust data bear little similarity to the mean wind data, for example, the largest number of maximum gusts occurs in autumn-winter while the period of highest mean wind speed is late winter-spring.

Cloud

The island is very cloudy. The minimum mean monthly cloud cover is about 60 per cent in August. Both morning (0900 h) and afternoon (1500 h) monthly cloud trends are irregular; broadly similar trends occur in summer and midwinter only. The southern mountains generate their own orogenic cloud cover (Figure 5) and are always cloudier than the lowlands. For most of the year there is consistently higher cloud cover in the afternoon (Figure 12). The rainday and hourly rainfall data both indicate that precipitation is chiefly as small falls. However, the lack of correlation between cloud cover and raindays (both those >0.25 and >2.5 mm) and rainfall (r = -0.310, r = 0.400 and r = -0.153 respectively, Table 3) indicates that on many cloudy days it does not rain.

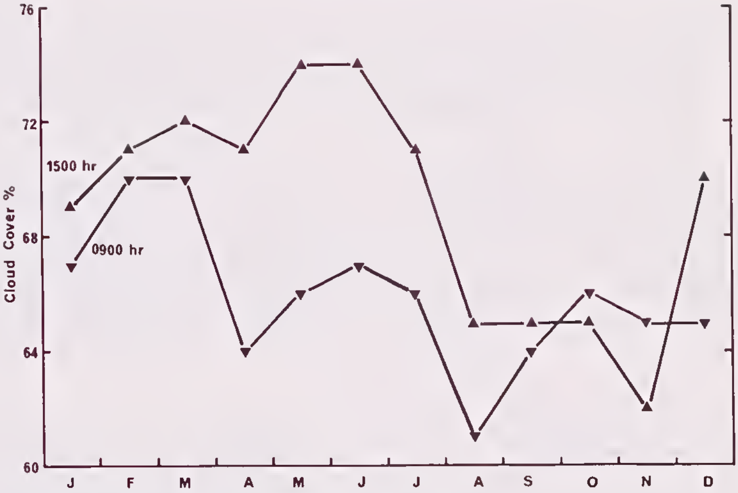

Figure 12. Mean monthly 0900 (▼) and 1500 (▲) h cloud cover.
Source: Bureau of Meteorology unpublished data, 10 years.

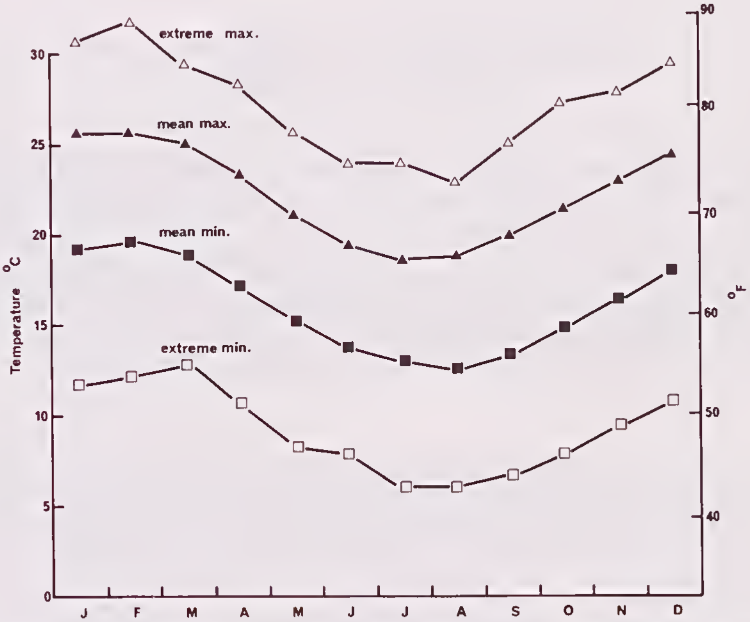

Figure 13. Mean (maximum ▲, minimum ■) and extreme (maximum △, minimum □) monthly temperatures. Source: Gentilli (1971), Anon. (1969), 27 years.

Temperature

Main annual temperature is 19.1°C and there is a consistent 7°C difference between mean maximum and minimum (Figure 13). The highest temperature ever recorded is either 31.5°C (Bureau of Meteorology, unpublished data) or 43.5°C (Russell, 1895). The lowest ever is 6.0°C (Bureau of Meteorology, unpublished data). No frosts have been recorded.

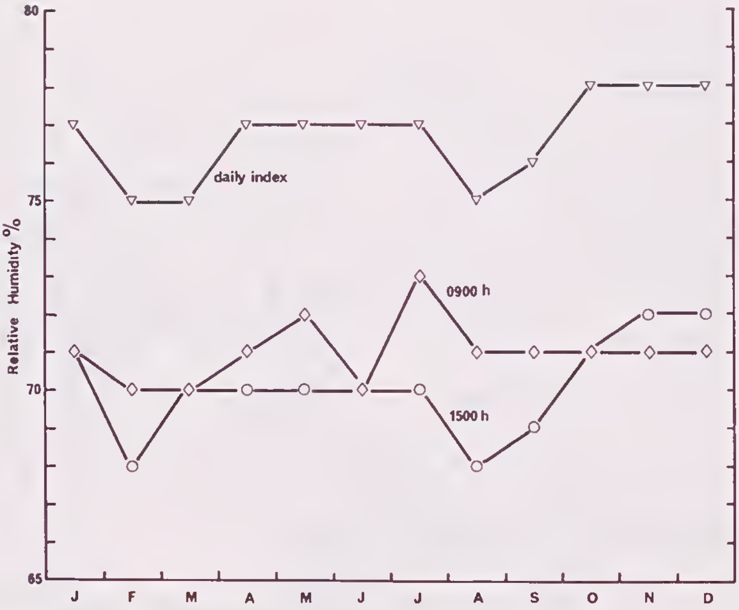

Figure 14. Mean monthly relative humidity.
Source: Anon. (1969), Gentilli (1971)—Daily index (▽) 28 years
Gentilli (1971)—0900 h (◇) 28 years
1500 h (○) 9 years

The temperature on the mountains can be estimated using a lapse rate of 5.5-8.0C degrees fall per 1000 m rise. Thus temperatures on the summits would be about 6-8°C lower than at the Meteorological Station and the mean minimum and extreme minimum at the Station would be equivalent to the mean maximum and mean minimum temperatures respectively on the mountain (Figure 13). These ranges agree with results from a maximum/minimum thermometer left on the summit of Mount Gower (875 m) from February 1974 to February 1975; a maximum of 25.5°C and a minimum of 0°C was recorded (H.J. de S. Disney, pers. comm.).

Relative Humidity

Not surprisingly, humidity on the island is always high (Figure 14). The morning (0900 h) humidity is between 70 and 73 per cent; and the afternoon (1500 h) varies between 68 and 72 per cent. The monthly trends for daily and afternoon (1500 h) humidity are similar but the morning (0900 h) trend is more erratic.

History of settlement

Lieutenant Henry Lidgbird Ball discovered Lord Howe Island on 17 February 1788 and it was first settled in 1833 or 1834. For the next 40 years or so the islanders depended on subsistence farming and fishing, supplemented by goods traded with passing whalers. By 1870 whaling had declined and the island's economy was based on the export of onions which had commenced about 1860. Fungal diseases destroyed the onion industry in 1875.

Palm seeds were exported in about 1880 and quickly became the major industry. However, competition between islanders was so cut-throat they received very little payment. Formation of the Kentia Palm Seed Co-operative Company in 1906 improved matters but conditions again worsened. In 1911, and again in 1912, Royal

Commissions investigated the industry (Langwell, 1911; Bevan, 1912) with profound consequences: land tenure changed from permissive occupancy to leasehold, a board of control was established and the New South Wales Government retained control of the seed industry. The industry crashed during World War I with loss of European markets and no labour for harvesting. The invasion of the island by rats in 1918 rang the death knell of the industry.

Tourists began visiting Lord Howe about 1925 and numbers gradually increased until tourism became the major industry. In 1955 the Lord Howe Island Act was passed to reconstitute management under the Lord Howe Island Board and to revise land tenure. Today the Island depends on tourism and a revitalized and better managed palm seed export which supplies the Board with income for essential public works. Nicholls (1951) and Rabone (1940, 1959) give further details of the history.

Fauna

Like many oceanic islands, Lord Howe has an impoverished fauna except for sea-birds. Fullager *et al.* (1974) estimate that up to 1 million pairs of sea-birds nest on the island. Most of these are Sooty Terns (*Sterna fuscata*)*, Wedge-tailed Shearwaters (*Puffinus pacificus*), Providence Petrels (*Pterodroma solandri*) and Fleshy-footed Shearwaters (*Puffinus carneipes*). Details of their distribution are given in Table 8, p.235). Several species of terrestrial birds also occur (Fullagar *et al.,* 1974). The only other native land vertebrates are two small reptiles, a gecko and a skink (Cogger, 1971), and a small insectivorous bat.

Several species have been deliberately introduced since 1788. Domestic livestock include cattle (*Bos taurus*), horses (*Equus caballus*), goats (*Capra hircus*), pigs (*Sus scrofa*) and chickens (*Gallus gallus*); pets include cats (*Felis catus*) and dogs (*Canis familiaris*). House mice (*Mus musculus*) were introduced accidently about 1868 and black rats (*Rattus rattus*) in 1918 (Hindwood, 1940). A few rabbits (*Oryctolagus cuniculus*) were reported on Rabbit Island in 1869 (Hill, 1870) but appear to have never roamed on Lord Howe itself. They were dead by 1887 (Etheridge, 1889a).

Horses, poultry, dogs, mice and to a lesser extent cats, are restricted to the cleared and settled areas and appear to have little effect on the vegetation. The distribution and effect of the other exotic animals are summarized in Table 9 (p.000). As I have considered the status and effects of goats, pigs, rats and cattle in detail elsewhere (Pickard 1976, 1978, unpublished data) they will only be discussed briefly here.

Early reports on the vegetation

Virtually every visitor to the island has commented, in greater or lesser detail, on the vegetation and the flora. All early descriptions are very general, for example, in February 1788, Ball (in Anon., 1789, p.180) saw ". . . cabbage-palms, mangroves and machineal trees even up to the summits of the mountains". Three months later, in May 1788, Watts (in Anon., 1789, p.223) expands this: "this island is well covered with wood, the chief of which is the large and dwarf mangroves, the bamboo and the cabbage tree. The different vegetables met with were scurvy grass, wild celery, spinach, endive and samphire."

Clearly the "cabbage tree" is *Howea* and/or *Hedyscepe.* Ball and Watts would not have seen *Lepidorrhachis* as it is restricted to the summits of Mounts Gower and Lidgbird. The "mangrove" is unlikely to be either *Avicennia* or *Aegiceras,* which are very restricted, and there is no evidence of greater or lesser numbers of mangroves

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*Authorities for sea-birds are given in Fullagar *et al.* (1974).

in the past. Both Ball and Watts were probably referring to any of a number of genera of common lowland trees with glossy dark leaves, including, for example, *Drypetes* or *Cryptocarya.* The "machineal" is probably either the red-fruited *Ochrosia elliptica,* a shrub of the hind dunes, or *Drypetes,* which also has a red fruit. The "bamboo" is most likely *Flagellaria indica.* Of the vegetables, "celery" refers to one of the *Apium* species, "samphire" to *Sarcocornia* and "spinach" to *Tetragonia,* but the others are unknown.

Subsequent reports from 1835 (White, 1853), 1851 (Foulis, 1853) and 1853 (Denham, 1853) are similar and add little. Denham was accompanied by John Denis MacDonald, whose report (1853) is difficult to obtain but the sections on vegetation are fully quoted by Maiden (1898). Macgillivray was the naturalist/zoologist with Denham on the *Herald* but his report (Macgillivray, 1854) is less detailed than MacDonald's.

In June 1869, Charles Moore, Director of the Botanic Gardens, Sydney, spent three days on the island. He was the first botanist to visit the island. Moore published six essentially identical papers on the island (Moore 1869-1871) but these are more concerned with the flora than the vegetation and his description is of little use for the vegetation study except for notes on abandoned gardens (see p.241).

If Moore's observations are accurate, his descriptions could indicate some local changes, for example, on the northern (i.e. eastern) side of the island "*Hibiscus Patersonii [Lagunaria patersonia], Ochrosia elliptica* and *Myoporum acuminatum [M. insulare]* . . . were reduced to a low-sized and nearly impenetrable scrub, the more so as they were usually intermixed with *Guilandina Bonducella [Caesalpinia bonduc],* as sub-climbing prickly shrub". In 1977 *Caesalpinia* was known from three sites; one in a small creek draining the NE flank of Transit Hill, the second on calcarenite between Old Settlement Beach and the Public Jetty and third on Neds Beach. This latter site is the one referred to by Moore and is a relatively short stretch of sandy cliff some 200 m long. Currently *Caesalpinia* could scarcely be described as "intermixed". Field notes on more recent specimens from this site (lodged in the National Herbarium of New South Wales) describe it as follows: "a few plants noted" (Boorman, date 1920), "a few scattered specimens" (Balgooy no. 1044, date 1965), and "two small colonies about 15 m apart" (Rodd no. 1491, date 1970). Thus either the abundance has altered, or Moore's description is coloured; the latter seems more likely. Moore further observed that ". . . *Viscum opuntioides [Korthalsella japonica]* . . . was observed growing in considerable quantities, but only upon two kinds of trees, *Hemicyclia [Drypetes]* and *Elaeodendron*". Maiden (1898) records *Korthalsella* also on *Cryptocarya triplinervis, Coprosma putida* and *Pimelea longifolia.* Oliver (1916) adds *Ochrosia elliptica* and I have seen it on *Alyxia ruscifolia* and *Dysoxylon pachyphyllum.* Once again it seems that Moore's observations are inadequate. R.D. FitzGerald and E.S. Hills, who accompanied Moore, give entertaining descriptions (in Anon., 1870) but add little detail.

In April 1882, J. Duff, a collector from the Botanic Gardens in Sydney, spent 13 days collecting on the island. His only observation worth noting here is "that the tree ferns formerly to be found on the banks of creeks, and other moist places of low land, at the foot of Mounts Gower and Lidgbird, are now nearly extinct, their disappearance being doubtless caused by plant collectors procuring the plants most accessible" (Duff, 1882). As fewer than 10 scientific collectors had visited the island, Duff must be referring to islanders collecting large quantities for the commercial trade. However, there is also evidence that pigs were widespread at that time and they could be partially responsible for the reduction in ferns. W. Botting Hemsley published a compilation of the flora in 1896 but as he had never visited the island his paper merely repeats previous descriptions. The next botanist to visit was Joseph Henry Maiden, Director of the Botanic Gardens in Sydney, who spent nine days on the island in March 1898. Maiden (1898) makes numerous observations on the flora and on the habits of the islanders, but adds little to the earlier descriptions of the vegetation. His subsequent papers (1899, 1901, 1902, 1914, 1920) add more detail on the flora. The Reverend W.W. Watts collected ferns and mosses in July-August 1911. His three papers (1912, 1914, 1915) refer specifically to ferns. He provides incidental information on some sites but these do not help detect changes.

The most complete report is that of W. Reginald B. Oliver who spent 15 days on the island in November 1913. Oliver (1917) systematically described a number of formations and associations which I have listed as synonyms in the Vegetation Table. He also described some areas in sufficient detail that comparisons are possible, for example, Little Slope (Pickard 1976, 1978, unpublished data) and New Gulch (see p.238). J.L. Boorman visited the island about 1920, but his observations appear to be very unreliable, for example, he says (Boorman, 1921) that *Cleistocalyx fullagari* ". . . grows about 50-80 ft. above sea-level never extending above or below this level." This is incorrect, as *Cleistocalyx* dominates stands from 150-450 m altitude in Erskine Valley, from 15 m to 250 m on Intermediate Hill, and from 80 to 120 m in the Northern Hills. Scattered individuals also occur beyond these ranges. As so many similar mistakes can be demonstrated, all his observations must be subject to doubt. There have been no recent detailed descriptions of the vegetation. Several botanists have visited and collected, for example, R.D. Hoogland (Canberra), A.C. Beauglehole (Melbourne) and P.S. Green (Kew), but they made no general ecological observations. Various visiting scientists from other disciplines have commented, in passing, on the vegetation (for example, Standard, 1963; Paramanov 1958, 1963). None of these reports is of much use in assessing changes.

VEGETATION

Methods

Sampling

Numerous traverses were made to sample as wide a range of vegetation as possible (Figure 15). On these traverses I made notes on salient features of the vegetation, paying particular attention to boundaries. With one or two exceptions, all data are qualitative and based on subjective judgements. Quantitative and semi-quantitative data were recorded for particular purposes from specially located sites and transects. Thus data from 73 randomly located sites used elsewhere for objective analysis of the vegetation (Pickard 1978, unpublished data) are incorporated here where relevant. Similarly palm height, stand density and basal area were measured at up to 312 points on 21 transects designed to sample variation in major palm-seeding areas (Pickard 1978, 1980).

Erection of vegetation units

Describing the process of erecting vegetation units for mapping is very difficult. Because of this, many ecologists criticize vegetation mapping for its subjectivity and apparent non-reproducibility. In recent years a plethora of reviews and comparisons of techniques has appeared (see, for example, Whittaker (1973) at one extreme or Küchler (1967) at the other). Rather than add to the already excessive literature I will attempt to describe how I arrived at the units shown on the vegetation map.

Before field work I read critically all available descriptions of the environment (Standard, 1963) and the vegetation (Maiden, 1898 *et seq.;* Moore, 1869 *et seq.;* and

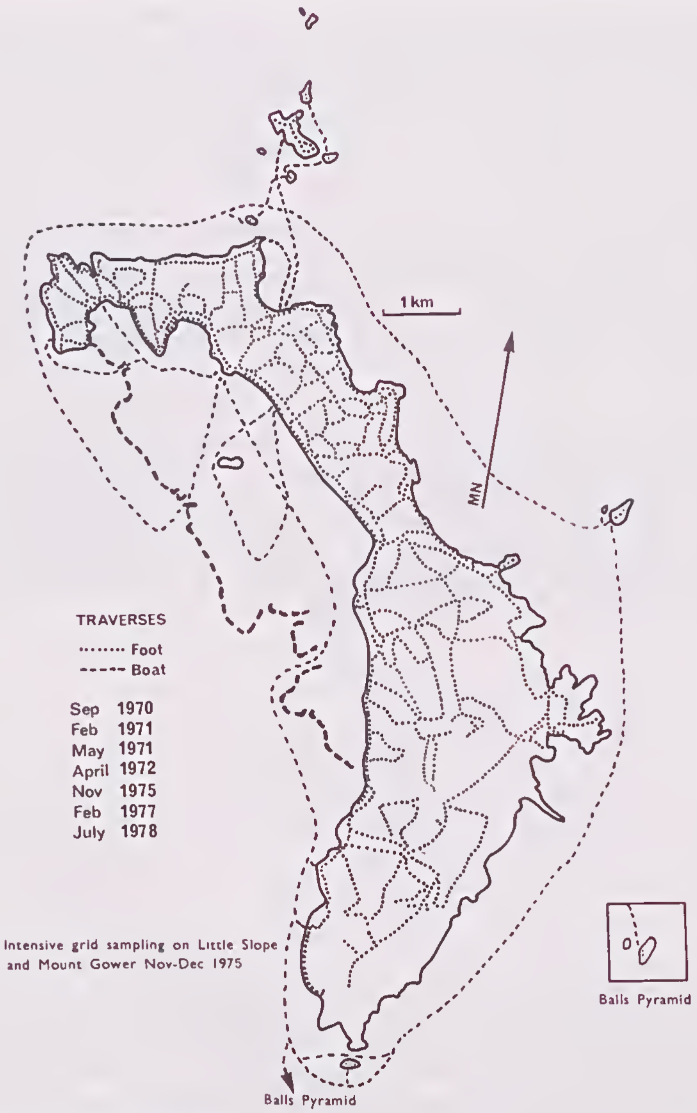

Figure 15. Field traverses on the island.

especially Oliver, 1917) and examined the airphotos to develop some familiarity with the island. During initial field work (September, 1970 and May, 1971) I was largely occupied learning to recognize the flora and forming impressions of the range of variation in the vegetation. This was formalized by airphoto interpretation and preliminary mapping (June, 1971). After considering the structural classifications of Specht (1969), UNESCO (1973), Webb (1959, 1968) and Fosberg (1967) I chose the last as being most intuitively satisfying in this vegetation at the scale of 1:15 840. Mapping of communities proceeded divisively at the formation level into forest, scrub, grass etc. At the association level I worked both divisively and agglomeratively with what appeared to me to be predominant species, that is, those classed as abundant, widespread and easily recognized. I made a conscious effort to map the vegetation using only vegetation characteristics and not features of the environment. However, the vegetation on some habitats such as beaches and cliffs is so heterogeneous that I mapped these areas as physiographic rather than vegetation units.

The first draft map was very uneven, with many fragmented units. This reflected my unfamiliarity with the range of variation of the vegetation, for example, the widespread *Drypetes-Cryptocarya* Alliance was subdivided into a large number of associations, facies and variants. These were erected in the first flush of enthusiasm in a new and unfamiliar environment. During subsequent field work I became more familiar with the variation, and reduced the number of units. This is the reverse of the "group-size dependency" property of some computer classification strategies (Clifford, 1976). In this case once a group is formed and grows by the addition of further individuals, the vegetation hyperspace is dilated and the groups appear to recede from all other groups. Thus, as it grows, it becomes progressively more difficult to join. In revising my earlier mapping the reverse occurred: I reduced the number of units by increasing the size of the large units. There is considerable inertia in the process and once the initial framework was erected no further major units were recognized.

Classification Hierarchy

The hierarchy of units is:

STRUCTURAL (after Fosberg, 1967)

Primary Structural Group
    Based on spacing e.g. Closed *vs* Open.
Formation
    Based on habit and stature e.g. Forest, Scrub, Grass etc.
Subformation
    Based on dominant growth-form with emphasis on leaf texture e.g. Orthophyll Grass, Sclerophyll Grass.

FLORISTIC

Alliance
    Based on the dominant genera e.g. *Howea.*
Association
    Based on the dominant species e.g. *Howea forsterana, Howea belmoreana.*

Where there is only one association in an alliance, the alliance has the same name.

Some of the structural category names appear unnecessarily complex, for example, "Megaphyllous broad sclerophyll forest" for "palm forest". These arise where other options in Fosberg's (1967) system do not occur on Lord Howe. I have used the full names for comparability with other areas because the International Biological Program adopted Fosberg's system as a standard.

Mapping

The map was prepared by air photo interpretation, field checking and reinterpretation combined with map correcting. Initial interpretation was on black and white vertical airphotos at 1:18 700 and 1:21 400 scales taken in April 1966. Incomplete coverage of colour photos at the same scales and date was used for checking. The appearance types were mapped onto a 1:15 840 topographic base map. All subsequent work was on maps at this scale. Some checks were made on 1975 vertical colour photos at scales 1:4 000 and 1:18 000. The final map was drawn using a combination of cartographic and photographic methods*. Since the first draft map was drawn most of the boundaries have been field checked and all the vegetation types have been examined many times in a range of sites. A summarized version of the map was published in Pickard (1974).

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*The vegetation map is in the pocket at the end of the paper.

Presentation of Results

(i) Field key to Associations: Mapping on any scale precludes showing small areas of an association on the map. These "inclusions" are difficult to describe but their existence can be noted in a tabular description. A more important consequence of inclusions is that the map may appear incorrect at a given location. For example, a user may be in an inclusion of *Drypetes-Cryptocarya* forest within what is mapped as palm forest of *Howea forsterana*. The key to vegetation allows a user to name a given stand independently from the map and retrieve the information in the vegetation tables.

(ii) Vegetation tables: Küchler (1967) and Whittaker (1973) have adequately reviewed the methods of describing vegetation but only Küchler pays attention to the presentation of results. A major weakness of prose descriptions of vegetation is elegantly described by Küchler (1967, 143) "A beautiful and eloquent description may be highly readable, and each individual aspect, thus described, can be visualized by the reader. But the usual subjective approach emphasizes one aspect here another there." Tabular descriptions are very common in the literature of terrain evaluation (e.g. Stewart, 1968; Mitchell, 1973). The main advantage is direct comparability of data and quick reference. Tabular descriptions have been successfully used by Boyland (1974) to describe vegetation as part of a wider terrain evaluation program. Independently I developed a tabular method for Lord Howe Island, based primarily on methods used by Grant (1975a, b).

The table forms the basis of the description of the vegetation associations erected during the survey. Each table presents a summary and the ranges of the data relevant to each association. This, together with the photograph, should be sufficient to give an adequate picture of the unit. Each association is fully described in the vegetation table, but relations between the units are difficult to perceive in that table. The complete hierarchy is set out in Table 4.

RESULTS

Key to Vegetation Associations

Users must distinguish between occurrences of individuals of a species and the occurrence of a vegetation association. For example, *Lagunaria patersonia* forms communities of Broad Orthophyll Swamp Forest on low-lying flats. Individuals and clumps occur also at the base of the cliffs at the southern end of Mount Lidgbird, but in this case *L. patersonia* is an integral segment of the flora of the *Dracophyllum fitzgeraldii-Metrosideros nervulosa* Association.

KEY

1. Closed vegetation, crowns or peripheries of plants mostly touching or overlapping.
2. Trees dominant. EVERGREEN CLOSED FOREST Formation
3. Dominated by generally straight trees and/or palms and/or pandans without extensive development of non-vascular epiphytes.
4. Dominated by trees with orthophyllous leaves generally much less than 250 mm long.
5. Forest on well-drained soils, lianes variable but abundant. Generally many tree and shrub species present. RAINFOREST Subformation

TABLE 4

Conspectus of associations

Formation	Subformation	Alliance	Association	Symbol
CLOSED FOREST	Rainforest	*DRYPETES-CRYPTOCARYA*	*Drypetes australasica-Cryptocarya triplinervis*	DaCt
			Drypetes australasica-Cryptocarya triplinervis exposed variant	DaCtx
			Drypetes australasica calcarenite variant	DaC
		CLEISTOCALYX-CHIONANTHUS	*Cleistocalyx fullagari*	Cf
			Chionanthus quadristamineus	Cq
			Lowland Mixed Forest	LM
		CRYPTOCARYA GREGSONII	*Cryptocarya gregsonii*	Cg
	Broad Orthophyll Swamp Forest	*LAGUNARIA*	*Lagunaria patersonia*	Lp
	Megaphyllous Broad Sclerophyll Forest	*HOWEA*	*Howea forsterana*	Hf
			Howea belmoreana	Hb
		HEDYSCEPE	*Hedyscepe canterburyana*	Hc
		PANDANUS	*Pandanus forsteri*	Pf
	Gnarled Mossy Forest	*BUBBIA-DRACOPHYLLUM*	*Bubbia howeana-Dracophyllum fitzgeraldii*	BhDf
CLOSED SCRUB	Broad Orthophyll Scrub	*BOEHMERIA-MACROPIPER*	*Boehmeria calophleba-Macropiper excelsum* var. *psittacorum*	BcMep
	Broad Sclerophyll Swamp Scrub	*AEGICERAS*	*Aegiceras corniculata*	Ac
	Narrow Sclerophyll Scrub	*MELALEUCA-CASSINIA*	*Melaleuca howeana*	Mh
			Cassinia tenuifolia	Ca
	Broad Sclerophyll Scrub	*DODONAEA*	*Dodonaea viscosa*	Dv
		DRACOPHYLLUM-METROSIDEROS	*Dracophyllum fitzgeraldii-Metrosideros nervulosa*	DfMn
DWARF SCRUB	Orthophyll Dwarf Scrub	*ATRIPLEX*	*Atriplex cinerea*	Ax
OPEN SCRUB	Broad Sclerophyll Swamp Scrub	*AVICENNIA*	*Avicennia marina* var. *australis*	Ama
BROAD LEAVED HERB VEGETATION		*IPOMOEA-CARPOBROTUS*	*Ipomoea cairica-Carpobrotus glaucescens*	IcCg
			Mixed Fern and Herb	MFH
TALL GRASS	Sclerophyll Tall Grass	*CYPERUS*	*Cyperus lucidus*	Cl
SHORT GRASS	Orthophyll Short Grass	*POA*	*Poa poiformis*	Pp
CLOSED AND OPEN SUBMERGED MEADOW	Submerged Meadow	*ZOSTERA-HALOPHILA*	*Zostera capricorni-Halophila ovalis*	ZcHo
PHYSIOGRAPHIC UNITS	Cliffs Coral Sand and Beach Basalt Boulder Beach Calcarenite Coral Boulder Beach			
DISTURBED AREAS				

6. Low to mid-height forest (6–9 m), generally dominated by *Drypetes australasica* and *Cryptocarya triplinervis*. Plank buttresses rare; leaves orthophyllous or ± sclerophyllous, microphyll and notophyll. Occupying a variety of habitats on basalt and aeolian calcarenite from sea level to 400 m but generally below 220 m elevation. *DRYPETES-CRYPTOCARYA* Alliance

7. Forest of variable height dominated by *Drypetes australasica* usually with *Cryptocarya triplinervis* as co-dominant. On a variety of sites but not subject to extremes of exposure or substrate.
Drypetes australasica-Cryptocarya triplinervis Association DaCt

7.* Low forest dominated by *Drypetes australasica; Cryptocarya triplinervis* present but not co-dominant. Shrubs abundant, lianes present, leaves sclerophyllous, microphyll with some notophyll. Occupying sites subject to environmental extremes.

8. Scrubby communities on exposed sites.
Drypetes australasica-Cryptocarya triplinervis exposed facies DaCtX

8.* Scrubby communities of steep outcrops of aeolian calcarenite.
Drypetes australasica calcarenite facies DaCtC

6.* Mid-height to tall forest (to 15 m) generally dominated by *Cleistocalyx fullagari, Chionanthus quadristamineus,* or *Cryptocarya gregsonii.* Plank buttresses occasional to common; leaves more orthophyllous particularly of understorey, leaves microphyll to megaphyll but chiefly notophyll and mesophyll. Occupying sites chiefly in the southern mountains generally up to 450 m elevation but some stands up to 610 m.

9. Dominated by *Cleistocalyx* and/or *Chionanthus* or with a range of dominants (excluding *Cryptocarya gregsonii*). Chiefly in the southern mountains up to 450 m elevation. *CLEISTOCALYX-CHIONANTHUS* Alliance

10. Tall monotypic forest of *Cleistocalyx fullagari* to 15 m, plank buttresses abundant, lianes occasional, with leaves generally notophyll.
Cleistocalyx fullagari Association Cf

10.* Mid-height (5–15 m); mixed forest, plank buttresses occasional.

11. Forest dominated by *Chionanthus quadristamineus,* often monotypic but commonly mixed. Trees with large (>20 mm diameter) fruits common; thick robust lianes common, few shrubs, palms common. On scree of large boulders with deep interstices. *Chionanthus quadristamineus* Association Cq

11*. Forest with no single dominant. On low-angle sheltered sites, particularly in southern mountains. Multistratal, many shrubs.
Lowland Mixed Forest LM

9*. Dominated by *Cryptocarya gregsonii,* on steep basaltic soils around the southern end of Mount Lidgbird between 350 and 660 m elevation.
CRYPTOCARYA GREGSONII Alliance
Cryptocarya gregsonii Association Cg

5*. Forest on low-lying poorly drained coal sand or aeolian calcarenite flats. Generally monotypic and dominated by *Lagunaria patersonia,* no shrubs present.
BROAD ORTHOPHYLL SWAMP FOREST Subformation
LAGUNARIA Alliance
Lagunaria patersonia Association Lp

4*. Dominated by palms and/or pandans with sclerophyllous leaves much longer than 250 mm.
MEGAPHYLLOUS BROAD SCLEROPHYLL FOREST Subformation

12. Palms dominant, either on aeolian calcarenite, coral sand or basalt.

13. Dominated by *Howea* spp. Generally lowland, but stands occur up to 360 m; on either aeolian calcarenite, coral sand or basalt. Non-vascular epiphytes rare, ferns common. *HOWEA* Alliance

14. Dominated by *Howea forsterana;* widespread on lowlands and up to 360 m, on either aeolian calcarenite, coral sand or basalt, if the latter then generally low-angle sites. Forest up to 20 m high, generally 15 m; emergents in patches up to 25 m high, understorey density and composition very variable.
Howea forsterana Association Hf

14*. Dominated by *Howea belmoreana;* less common on lowlands, restricted to the northern hills and southern mountains up to 250 m elevation, on basalt, often on scree slopes. Forest up to 12 m high with few or no emergents. Understorey generally sparse and scattered. *Howea belmoreana* Association Hb

13*. Dominated by *Hedyscepe canterburyana.* Lower montane, between 335 and 830 m elevation and generally above 610 m; always on basalt, generally stony and wet soil, often on high-angle sites. Low forest to 8 m high with dense understorey. Non-vascular epiphytes and ferns abundant.
HEDYSCEPE Alliance
Hedyscepe canterburyana Association Hc

12*. Pandans and mesic trees dominant, always on basalt, generally in moist sheltered gullies and valleys, from sea level to 150 m elevation. Generally on low-angle sites with impeded drainage but some stands are on sites with slopes >20°. Shrubs and small trees sparse, herbs sparse. *PANDANUS* Alliance
Pandanus forsteri Association Pf

3*. Dominated by generally gnarled trees and straight palms, with extensive development of non-vascular epiphytes. Dominated by *Bubbia howeana* and *Dracophyllum fitzgeraldii.* Never found below 750 m elevation.
GNARLED MOSSY FOREST Subformation
BUBBIA-DRACOPHYLLUM Alliance
Bubbia howeana-Dracophyllum fitzgeraldii Association BhDf

2*. Trees not dominant.

15. Shrubs and dwarf shrubs dominant.

16. Shrubs >1.5 m high dominant.
CLOSED EVERGREEN SCRUB Formation

17. Orthophyll shrubs dominant. High altitude community, multiple stems prominent, tree ferns abundant, filmy ferns and terrestrial mosses abundant. Dominated by *Boehmeria calophleba* and *Macropiper excelsum* var *psittacorum* generally restricted to above 610 m elevation.
BROAD ORTHOPHYLL SCRUB Subformation
BOEHMERIA-MACROPIPER Alliance
Boehmeria calophleba-Macropiper excelsum var *psittacorum* Association BcMep

17*. Sclerophyll shrubs dominant.

18. Dominated by broad-leaved shrubs.

19. Dominated by mangroves, dense scrub communities in tidal estuaries. One layer only. *Aegiceras corniculata* dominant and monotypic, pneumatophores rare, some invasion by herbs at fringes. Dense canopy to 4.5 m. Disturbed stands are virtually open scrub and have mid-dense field layer of succulent herbs.
BROAD SCLEROPHYLL SWAMP SCRUB Subformation
AEGICERAS Alliance
Aegiceras corniculata Association Ac

19*. Not dominated by mangroves; scrub communities of variable density on steep slopes, more than one layer.
BROAD SCLEROPHYLL SCRUB Subformation

20. Dominated by *Dodonaea viscosa.* Rather sparse closed scrub to 5 m high with dense sedge understorey. Leaf size mesophyll. On basalt sites between 30 and 300 m elevation. Few other shrub species present.

DODONAEA Alliance
Dodonaea viscosa Association Dv

20*. No single dominant. Dense but variable scrub to 6.5 m high with fern and herb understorey. Leaf size very variable, from megaphyll to nanophyll. On basalt sites between 340–610 m elevation and generally between 380–530 m. Many shrub species present, palms and tree-ferns conspicuous.

DRACOPHYLLUM-METROSIDEROS Alliance
Dracophyllum fitzgeraldii-Metrosideros nervulosa Association DfMn

18*. Dominated by shrubs with narrow nanophyll leaves.

CLOSED EVERGREEN SCLEROPHYLL SCRUB Formation
GREEN MICROPHYLLOUS EVERGREEN SCRUB/NARROW SCLEROPHYLL SCRUB Subformation
MELALEUCA-CASSINIA Alliance

21. Dominated by *Melaleuca howeana.* Dense scrub to 4 m high, but occasionally to 6 m, with even surface, generally appearing dark green. On exposed sites, both basalt and calcarenite, usually <150 m elevation.

Melaleuca howeana Association Mh

21*. Dominated by *Cassinia tenuifolia.* Dense scrub to 5 m with uneven surface, generally appearing light blue or grey. On exposed basalt sites, usually <150 m elevation.

Cassinia tenuifolia Association Ca

16*. Dwarf shrubs <1.5 m high dominant. Dense communities to 1 m high on unstable talus material below Malabar and at Middle Beach. Dominated by *Atriplex cinerea,* some grass present.

DWARF SCRUB Formation
ORTHOPHYLL DWARF SCRUB Subformation
ATRIPLEX Alliance
Atriplex cinerea Association Ax

15*. Herbs and graminoids dominant.

22. Dominated by broad-leaved herbs.

BROAD-LEAVED HERB Formation
EVERGREEN BROAD-LEAVED WEEDY VEGETATION Subformation

23. Dominated by twiners and herbs: *Ipomoea cairica, Carpobrotus glaucescens* and *Commelina cyanea.* On coastal cliffs and off-shore islands, very exposed sites.

IPOMOEA-CARPOBROTUS Alliance
Ipomoea cairica-Carpobrotus glaucescens Association IcCg

23*. No single dominant although ferns prominent. Generally at bases of cliffs in southern mountains, also on landslide scars.

MIXED FERN AND HERB Alliance
Mixed Fern and Herb Association MFH

22*. Not dominated by broad-leaved herbs.

24. Dominated by grass or graminoids.

25. Dominated by graminoids taller than 1 m. Dominated by sclerophyllous sedges with erect leaves narrower than 5 cm. Dominated by *Cyperus lucidus,* in a variety of sites generally of low elevation and close to coast.

TALL GRASS Formation
SCLEROPHYLL TALL GRASS Subformation
CYPERUS Alliance
Cyperus lucidus Association Cl

25*. Dominated by orthophyllous grasses, less than 1 m tall, generally weeping.

Dominated by *Poa poiformis,* exposed sites at low elevations close to coast and generally within reach of salt spray.
SHORT GRASS Formation
ORTHOPHYLL SHORT GRASS Subformation
POA Alliance
Poa poiformis Association Pp

24*. Dominated by *Zostera capricorni* and *Halophila ovalis* on floor of lagoon.
CLOSED SUBMERGED MEADOW Formation
SUBMERGED MEADOW Subformation
ZOSTERA-HALOPHILA Alliance
Zostera capricorni-Halophila ovalis Association ZcHo

1*. Open or sparse vegetation, crowns or peripheries of plants mostly not touching.

26. Generally dominated by *Cryptocarya gregsonii,* on steep basaltic soils in southern mountains between 350 and 610 m elevation. Tree layer open although scrub layer may be closed.
OPEN FOREST Formation
CRYPTOCARYA GREGSONII Alliance
Cryptocarya gregsonii Association Cg

(Open phases of other forests are not separated from the more common closed phases.)

26*. Dominated by *Avicennia marina* var. *australasica* in shingle and mud on shore of Hunter Bay.
OPEN SCRUB Formation
BROAD SCLEROPHYLL SWAMP SCRUB Subformation
AVICENNIA Alliance
Avicennia marina var. *australasica* Association Ama

Vegetation Table

Each association in the Vegetation Table is described over two pages where the information is arranged in a series of blocks. I have tried to present the descriptions in a systematic manner to facilitate comparison of associations and retrieval of information. Although much of the table is self-explanatory the following notes will help in some sections.

BLOCK 1. FORMATION. The hierarchy used is listed in Table 4. The **formation** and **subformation** to which each association belongs was determined using Fosberg's (1967) key. The **number** is the number of the subformation in Fosberg's structural classification. It is included here to facilitate comparison with other areas. The **alliance** is the highest floristic category used in this paper. The name gives the alliance to which the association has been assigned.

BLOCK 2. NAME. The full name of the **association** is given. The **symbol** is generally formed from the initial letters of the generic and specific names of the dominants. It is used elsewhere in the table and on the vegetation map. The **area** was estimated using a dot grid laid over the map. **Oliver equivalent** is the name (if any) of the association described by Oliver (1917) which best applies to the unit(s) erected here. The **UNESCO equivalent** to the formation and subformation of Fosberg (1967) is listed to allow comparison with other areas where the UNESCO (1973) system has been used. Although the UNESCO system was designed for scales of 1:1 million and smaller, the formations on Lord Howe are sufficiently dissimilar to allow its use at a scale of 1:15 840.

BLOCK 3. PHYSIOGRAPHY. A general description of the type of site the association usually occupies. This is described in the following order: altitude, aspect, slope, exposure and position on slope. The last is an indication of the topographic position of the association on a scale: top, shoulder, upper-, mid-, lower- and toe-slopes and flats. Other categories, for example, cliffs are self-explanatory. The usual **geological substrate** of the association is briefly described. Similarly, **soil** features are listed. The abbreviations follow Northcote (1971). Other relevant data are also listed.

BLOCK 4. MAP. The shaded area shows the distribution of the association. The **photograph** shows a typical stand of the community (also see the photographs listed in Block 10).

BLOCK 5. STRUCTURE. These are typical values for the community. **Basal area** values are mostly single results measured using glass prisms (Dillworth & Bell, 1974) calibrated in sq ft/ac and converted to sq m/ha. **Emergents** are defined as outstanding plants whose crowns are exposed on all sides above the main canopy (Webb *et al.,* 1976). Their **distribution** is described on a four point scale: scattered, very scattered, occasional and none. The **canopy** is the more or less continuous leafy layer formed by the crowns of the tallest plants which touch or almost touch one another (Webb *et al.,* 1976). The **surface** of the canopy is described on a scale of roughness, as follows: smooth, even (variation in height <¼ of total height), uneven (variation in height >¼ of total canopy height). Webb *et al.,* (1976) use and illustrate a similar scale. **Cover** is a four-point scale to describe the density of the main canopy: closed (adjacent crowns are touching or overlapping), dense (the average space between crowns is less than the diameter of the crowns), mid-dense (average spacing is greater than one crown diameter), sparse (average spacing is greater than two crown diameters), and open (average spacing is much greater than two crown diameters). **Strata number** are frequently difficult to recognize, and I doubt their value in descriptions. However, I have included them as an index of vertical complexity of the associations. **Boundaries** refers to the nature of the boundaries between the strata i.e., their distinctiveness. **Composition** of the strata is described in conventional terms. The **ground vegetation** is defined as less than 1 m high. In low formations, for example, Short Grass, this is equivalent to the canopy. The **density** is described in general terms and the **composition** noted. **Special life-forms** is something of a misnomer but includes such types as pandans, palms, lianes and epiphytes. To call palms on Lord Howe Island 'special' is incorrect because they occur over most of the island and dominate some 18 per cent of the vegetation.

BLOCK 6. STRUCTURAL FEATURES OF CANOPY PLANTS. The features listed are useful in describing a community and have been used successfully, both subjectively (Webb 1959, 1968; Pickard 1974, 1978) and objectively (Webb *et al.* 1970, 1976; Pickard 1978), to classify rainforest and other vegetation. The **life-form** of the plant making up the canopy is listed. The **density** and **shape** of the **crown** is described in general terms. The lowest **position of branches** on the stems is described using the following scale (illustrated in Webb *et al.,* 1976): uppermost top, upper third, about half-way down stem, more than half-way down stem, and at or near the base of the stem. The angle the branches make with the stem is crudely described under "**type**" as either horizontal or divergent. **Stems** are described rather simply in terms of their straightness: straight, crooked, leaning, bent at base and branchy. **Bark** textures grade into one another in the field, but one form or other is frequently more prominent in the community. Six types are common on Lord Howe Island: smooth and glassy, smooth with fine cracks, smooth but with small spikes, flaky in patches, rough and flaky, and fibrous. **Roots** are described as 'normal' if there is no sign of swelling or buttresses at the base of the stem. Five other categories are used: slight swelling at the base of the stem, spur buttresses, plank and other large buttresses, stilt roots, and surface spreading roots. **Leaf size** is estimated in the five classes of Webb (1968): nanophyll (<2.5 cm long), microphyll (2.5–7.5 cm long), notophyll (7.5–12.5 cm long), mesophyll (12.5–25 cm long) and megaphyll (>25 cm long). Leaf **shape** is classed into broad, linear and narrow; **margins** into entire, toothed and dissected. Leaf **texture** classes follow Fosberg (1967): sclerophyll, leathery, orthophyll and succulent.

BLOCK 7. DISTURBANCE. Many communities are disturbed to varying degrees. This is more fully described in the text and only summmarized here. The disturbing **agent** is listed and the **degree** of disturbance noted. This refers to both the whole community as well as individual stands. The main **locations** of disturbance are described in regional terms. The nature of the disturbance and other relevant information are listed also.

BLOCK 8. FLORISTICS. The common species in each life-form category are listed. If a species which normally grows to be a tree occurs as a shrub or small tree in the community, it is listed under the latter. Naturalized species are indicated with an asterisk(*).

BLOCK 9. INCLUSIONS. The presence of any inclusions of other communities is noted using the symbol of the relevant association. The **relationship** of the association to other communities is briefly noted, again using the symbols. **Boundaries** between communities in the field are frequently not as abrupt as the boundaries on the map imply; they are more realistically described here.

BLOCK 10. OTHER DATA. Any other relevant information is listed. Under **sites** are listed the numbers of the sites used in the objective survey (Pickard 1978, unpublished data) on which the community occurs. Similarly, the numbers of sites which support disturbed vegetation are listed. Any **photographs** of the association used as Figures in the text are listed.

Abbreviations:		
	n.a.	not applicable
	n.d.	not determined

FORMATION: Evergreen Closed Forest SUBFORMATION: Rainforest

Number: 1A1.1 Alliance: DRYPETES-CRYPTOCARYA

DRYPETES AUSTRALASICA—CRYPTOCARYA TRIPLINERVIS

Symbol: DaCt Area: 355 ha, 23.4%

Oliver equivalent: Lowland low forest *Hemicyclia australasica [Drypetes australasica]* Association

UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4a

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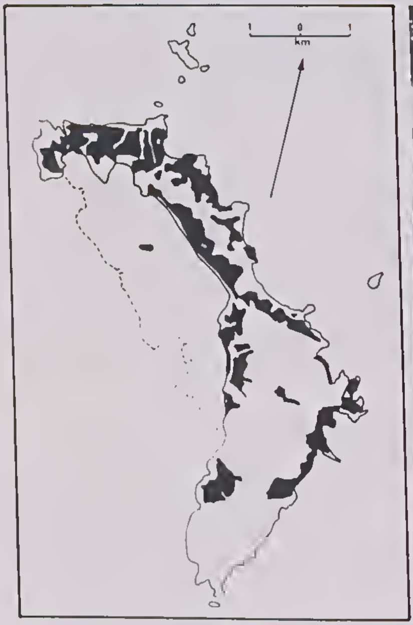
PHYSIOGRAPHY

Generalized site description: Altitude 0–400 m, generally <220 m; all aspects, common on S and W; 0°–50° slope; exposure moderate to low; top to toe-slope and flat.

Geology: Basalt and calcarenite and recent coral sand

Soil: Variable, Uf



Georges Bay Ridge, E of Boat Harbour.
Altitude 60 m.

STRUCTURE Basal area: 717 sq m/ha

Emergents Height:20 m Distribution: Occasional, patches

Canopy Height:13 m Surface: Variable
Cover: Dense-sparse Strata number: 4 Boundaries : Diffuse
Composition: Trees, small trees, shrubs, herbs.

Ground vegetation (<1 m) Density: Variable
Composition: Herbs, sedges, creepers.

Special life-forms: Pandans variable, from absent to abundant; palms variable; lianes common; vascular epiphytes occasional.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Dense
Shape: Round
Branch position: Upper third and half
Type: Divergent
Stem: Straight

Bark: Smooth, fine cracks
Roots: Normal, slight swelling

Leaf size: Notophyll
Shape: Broad
Margin: Entire
Texture: Sclerophyll, leathery

DISTURBANCE

Agent: Pigs, goats, man

Degree: 0–100%

Location: Various—pigs on Fern Patches, goats on Northern Hills, man on lowlands.

Pigs—rooting up of herbs etc.; goats—localised only; man—all forms of clearing, grazing of domestic stock.

FLORISTICS (common species only)

Trees
Cryptocarya triplinervis
Drypetes australasica
Elaeodendron curtipendulum
Howea belmoreana
Howea forsterana
Lagunaria patersonia
Olea paniculata
Pandanus forsteri

Shrubs
Cassinia tenuifolia
Myoporum insulare
Rapanea spp.
Xylosma spp.

Lianes
Malaisia scandens
Smilax australis

Herbs
Commelina cyanea

Sedges
Carex hattoriana

Ferns
Adiantum hispidulum
Asplenium oblongifolium

INCLUSIONS: Small areas of most recorded units.

Relationship to other units: Structurally to Cf, Lg and LM;
floristically to Hf, Hb and other forests.

Boundaries: Generally merge with most adjoining units especially Ca, Mh, DaCtX etc.

OTHER DATA

Lowest recorded basal area 435 sq m/ha, highest 1132 sq m/ha.
As the unit is very variable, the values of the parameters and descriptors may not be typical of individual sites and stands.

Sites: 2, 8, 18, 23, 32, 34, 46, 47, 53, 60.

Disturbed sites: 42, 49, 54, 55, 71.

Photographs: 29, 30, 31, 33, 34, 37, 38, 39, 40, 43, 45, 46, 49, 50.

FORMATION: Evergreen Closed Forest   SUBFORMATION: Rainforest-Mesophyllous Forest

Number: IA1.1–IB1.4a   Alliance: DRYPETES-CRYPTOCARYA

DRYPETES AUSTRALASICA—CRYPTOCARYA TRIPLINERVIS EXPOSED FACIES

Symbol: DaCtX   Area: 62 ha, 4.1%

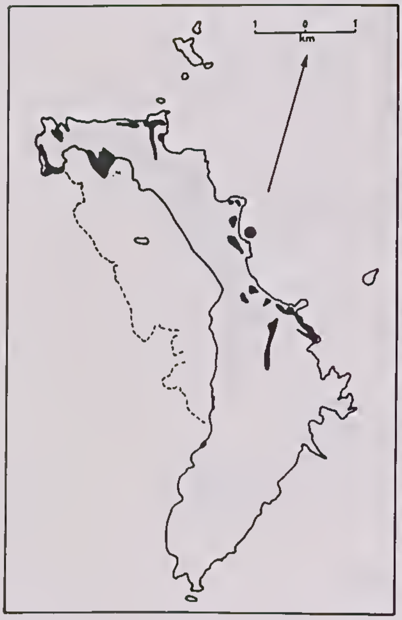
Oliver equivalent: Hill scrub *Hemicyclia australasica [Drypetes australasica]* Association

UNESCO equivalent: Subtropical ombrophilous lowland forest IA4.a; evergreen broad-leaved sclerophyll thicket IIA1.d

PHYSIOGRAPHY

Generalized site description: 0–250 m, generally <210 m; all aspects; low slope to 30°; very exposed; ridge summits and cliff tops.

Geology: Basalt   Soil: Stony surface of angular to subround basalt rocks c.150 mm.



Side of Dawsons Point Ridge above Wedding Lilies. Altitude 60 m.

STRUCTURE

Basal area: 639 sq m/ha

Emergents Nil

Canopy Height: 2–4 m   Surface: Even
Cover: Closed   Strata number: 2   Boundaries: Sharp, distinct
Composition: Small trees, herbs; occasionally a shrub layer is present.

Ground vegetation (<1 m)   Density: Mid-dense
Composition: Grasses, sedges, herbs and creepers.

Special life-forms: Vascular epiphytes common, lianes abundant, small palms occasional.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Dense
Type: Divergent

Shape: Round-flat Branch position: More than half
Stem: Erect, usually short

Bark: Smooth, fine cracks

Roots: Normal, surface

Leaf size: Micro-, some notophyll
Texture: Sclerophyll

Shape: Broad Margin: Entire

DISTURBANCE

Agent: Goats

Degree: Low

Location: Cliff edges in Northern Hills.

This disturbance is of local impact only. It is typified by destruction of trees and shrubs and growth of introduced plants.

FLORISTICS (common species only)

Trees
Baloghia lucida
Cryptocarya triplinervis
Drypetes australasica
Elaeodendron curtipendulum
Lagunaria patersonia

Shrubs
Alyxia ruscifolia
Cassinia tenuifolia
Dodonaea viscosa
Leucopogon parviflorus
Pimelea congesta

Lianes
Jasminum didymum
Smilax australis

Herbs
Commelina cyanea

Sedges
Carex hattoriana
Scirpus nodosus

INCLUSIONS: Some Ca, Mh and Cliff.

Relationship to other units: Close to Ca, Mh and DaCt.

Boundaries: Merges with Ca, DaCt and Cliff.

OTHER DATA

Some local occurrences of rare plants; *Koeleria phleoides, Cheilanthes distans, Plectorrhiza erecta, Pyrrosia confluens* and *Dianella intermedia.*
Some very stunted forms (e.g. slopes of Mount Eliza) have the appearance of scrub but have affinities with DaCtX.

Sites: 26, 53, 59, 60, 63, 68.

Disturbed sites: Nil.

Photograph: 25.

FORMATION: Evergreen Closed Forest
SUBFORMATION: Rainforest
Number: 1A.1
Alliance: DRYPETES-CRYPTOCARYA

DRYPETES AUSTRALASICA CALCARENITE FACIES

Symbol: DaCtC
Area: 2 ha, 0.1%

Oliver equivalent: Lowland low forest *Hemicyclia australasica [Drypetes australasica]* Association.

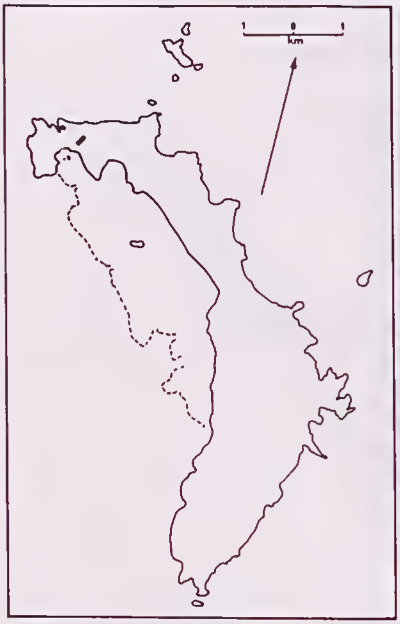
UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4.a

PHYSIOGRAPHY

Generalized site description: 15–70 m altitude, S and W aspect; slope 5° to cliffs, generally 10°–30°; ± zero to very exposed; on ridge top and top-slope.

Geology: Calcarenite
Soil: Stony, probably Uc

Other: Many outcrops of calcarenite, surface littered with plates and blocks of calcarenite.



Ridge above The Pulpit, North Beach area.
Altitude 40 m.

STRUCTURE

Basal area: 350 sq m/ha

Emergents Nil

Canopy Height: 4 m
Surface: Smooth
Cover: Mid-dense
Strata number: 2
Boundaries: Sharp
Composition: Small trees and herbs. Shrubs abundant in exposed sites.

Ground vegetation (<1 m)
Density: Sparse
Composition: Herbs, sedges and twiners.

Special life-forms: Lianes prominent locally.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Mid-dense
Shape: Round
Branch position: Upper half
Type: Divergent
Stem: Straight-crooked

Bark: Smooth
Roots: Normal and surface spreading

Leaf size: Notophyll
Shape: Broad
Margin: Entire
Texture: Sclerophyll, leathery

Many stems are light in colour.

DISTURBANCE

Agent: —

Degree: Virtually nil.

Location: —

FLORISTICS (common species only)

Trees
Cryptocarya triplinervis
Drypetes australasica
Elaeodendron curtipendulum
Howea forsterana
Planchonella myrsinoides

Shrubs
Alyxia ruscifolia
Cassinia tenuifolia
Myoporum insulare
Pimelea congesta

Lianes
Smilax australis

Grasses & Sedges
Carex hattoriana
Oplismenus imbecillus

INCLUSIONS: Nil.

Relationship to other units: Scrubbier phases close to Ca and Mh; entire unit close to DaCt; close to DaCtX although fewer shrubs.

Boundaries: Sharp to Cf; diffuse to DaCt.

OTHER DATA

This is a facies of DaCt restricted by the nature of the substrate and exposure.

Sites: Nil.

FORMATION: Evergreen Closed Forest
SUBFORMATION: Rainforest
Number: 1A1.1
Alliance: CLEISTOCALYX-CHIONANTHUS

CLEISTOCALYX FULLAGARI

Symbol: Cf
Area: 126 ha, 8.3%

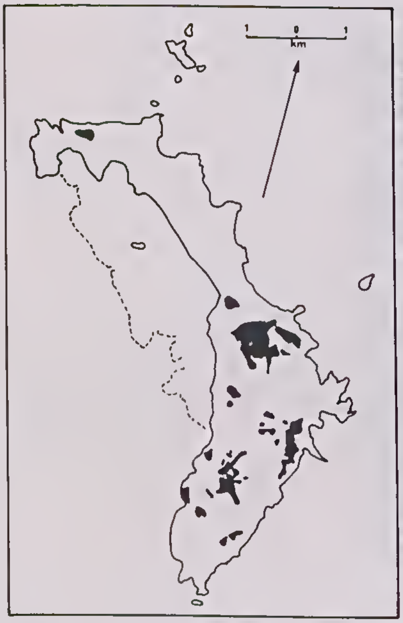
Oliver equivalent: Upland high forest *Acicalyptus Fullagari [Cleistocalyx fullagari]* Association

UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4.a

PHYSIOGRAPHY

Generalized site description: Altitude 0–490 m; E, N and W aspects; slopes 5°–35°; moderately exposed; mid- and top-slopes, rarely on toe-slope.

Geology: Basalt
Soil: Stony
Other: Only found on screes of large boulders if interstices are soil-filled.



W foot of Intermediate Hill.
Altitude 16 m.

STRUCTURE

Basal area: 850 sq m/ha

Emergents Height: 13 m
Distribution: Scattered, patches

Canopy Height: 12 m
Cover: Closed
Composition: Trees, small trees, herbs.
Surface: Even
Strata number: 3
Boundaries: Reasonably sharp

Ground vegetation (<1 m)
Composition: Sedges, creepers and ferns.
Density: Mid-dense

Special life-forms: Lianes occasional, tree-ferns occasional.

STRUCTURAL FEATURES OF CANOPY PLANTS
Life-form: Tree

Crown density: Mid-dense to dense
Type: Divergent
Shape: Slightly flat on top.
Stem: Straight and leaning
Branch position: Upper half

Bark: Flaky in patches
Roots: Large plank buttresses

Leaf size: Notophyll
Texture: Sclerophyll
Shape: Broad
Margin: Entire

Dead wood common in crowns.

DISTURBANCE
Agent: Man, pigs

Degree: Low to severe

Location: Transit Hill, Erskine Valley.

Pigs rooting disrupt ground cover leaving a ± bare soil surface.

FLORISTICS (common species only)

Trees
Chionanthus quadristamineus
Cleistocalyx fullagari
Guioa coriacea
Howea belmoreana

Small trees
Bubbia howeana
Randia stipulosa

Sedges
Carex hattoriana

Ferns
Pteris microptera

INCLUSIONS: Some Cq, LM and Hb.

Relationship to other units: Close to Cq with which it may merge.

Boundaries: Generally very sharp but may merge into DfMn and LM.

OTHER DATA

Stands of Cf generally project above adjacent communities.

Sites: 7, 24, 36, 38, 39, 45, 67.

Disturbed site: 43.

FORMATION: Evergreen Closed Forest
Number: 1A1.1

SUBFORMATION: Rainforest
Alliance: CLEISTOCALYX-CHIONANTHUS

CHIONANTHUS QUADRISTAMINEUS

Symbol: Cq

Area: 93 ha, 6.1%

Oliver equivalent: Mountain low forest *Notelaea quadristaminea [Chionanthus quadristamineus]* Association

UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4.a

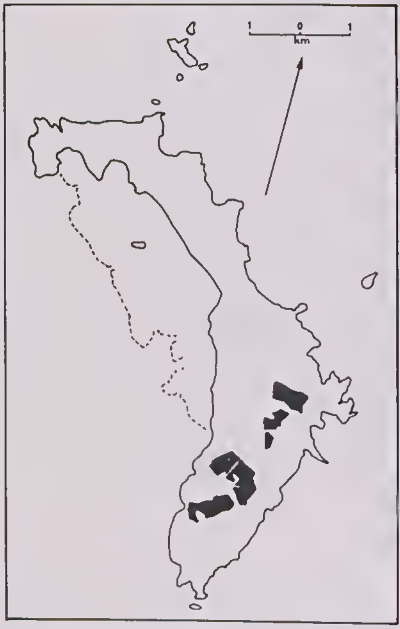
PHYSIOGRAPHY

Generalized site description: Altitude 75–450 m; all aspects; slope 10°–30°; low to moderate exposure; mid-slope and in some gullies.

Geology: Basalt

Soil: Unknown, very stony

Other: Common scree of large boulders (0.5–3 m) with deep interstices.



N side of Erskine Valley.
Altitude 400 m.

STRUCTURE

Basal area: n.d.

Emergents: Nil

Canopy Height: 10 m
Cover: Mid-dense
Composition: Trees, small trees, herbs.

Surface: Even-uneven
Strata number: 3

Boundaries: Sharp-diffuse

Ground vegetation (<1 m)
Composition: Ferns, sedges, creepers, mosses.

Density: Variable

Special life-forms: Lianes abundant, hummock-forming mosses may be locally common on surfaces of boulders.

STRUCTURAL FEATURES OF CANOPY PLANTS		Life-form: Tree
Crown density: Mid-dense Type: Divergent	Shape: Round Stem: Crooked	Branch position: Upper half
Bark: Smooth	Roots: Unknown	
Leaf size: Mesophyll Texture: Leathery	Shape: Broad	Margin: Entire

Large woody fruits.

DISTURBANCE Agent: Pigs

Degree: Low to moderate

Location: Southern mountains.

Although surface soil is sparse and shallow between the boulders, pigs root up ferns and sedges.

FLORISTICS (common species only)

Trees
Chionanthus quadristamineus
Dracophyllum fitzgeraldii
Howea belmoreana
Symplocos candelabrum

Small trees
Bubbia howeana
Dysoxylum pachyphyllum

Shrubs
Coprosma spp.

Lianes
Flagellaria indica
Malaisia scandens

Ferns
Cyathea spp.
Histiopteris incisa
Microsorium howense
Pteris microptera

INCLUSIONS: Hb, Cf, DaCt, DfMn and LM.

Relationship to other units: Appears floristically distinct although the closest affinities are with Cf.

Boundaries: Sharp-diffuse.

OTHER DATA

Generally the dominant vegetation on large boulder screes, with little soil material, in Erskine Valley and the southern mountains in general.

Sites: 11, 12, 19.

FORMATION: Evergreen Closed Forest
SUBFORMATION: Rainforest
Number: IA1.1
Alliance: CLEISTOCALYX—CHIONANTHUS

LOWLAND MIXED FOREST

Symbol: LMF
Area: 192 ha, 12.6%

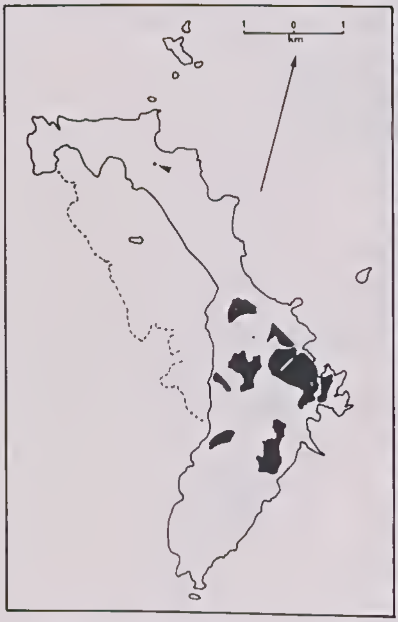
Oliver equivalent: Nil

UNESCO equivalent: Subtropical ombrophilous lowland forest IA4.a

PHYSIOGRAPHY

Generalized site description: Altitude 30–375 m; E and W aspects, although also on N and S; slope variable 0°–40°; exposure moderate to low; mid-slope to valley bottom, occasionally on top-slope.

Geology: Basalt
Soil: Very stony, probably Uf



Peach Tree Ridge, W of Intermediate Hill. Altitude 150 m.

STRUCTURE

Basal area: 740 sq m/ha

Emergents Height: 20 m
Distribution: Occasional or rare

Canopy Height: 7–13 m
Cover: Mid-dense
Surface: Even-uneven
Strata number: 3
Boundaries: Diffuse
Composition: Trees, small trees, herbs. Shrubs usually uncommon.

Ground vegetation: (<1 m)
Density: Dense
Composition: Seedlings, herbs, sedges and creepers.

Special life-forms: Pandans common; palms common; lianes and epiphytes common.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Mid-dense

Shape: Variable

Branch position: Upper half

Type: Divergent

Stem: Erect, straight

Bark: Variable, usually smooth

Roots: Normal, some spurs, planks and stilts

Leaf size: Micro- to megaphyll

Shape: Broad

Margin: Entire

Texture: Orthophyll and sclerophyll

Compound leaves occasional, driptips occasional.

DISTURBANCE

Agent: Pigs

Degree: Low to severe

Location: Erskine Valley, Fern Patches, valley of Rocky Run.

The effect is variable. In extreme cases the pigs leave a loose mobile soil surface littered with pebbles after killing the ferns and sedges.

FLORISTICS (common species only)

Trees
Cleistocalyx fullagari
Euodia polybotrya
Guioa coriacea
Hedyscepe canterburyana
Howea belmoreana
Olea paniculata
Pandanus forsteri

Small trees
Bubbia howeana
Coprosma putida
Psychotria carronis
Xylosma spp.

Shrubs
Cassinia tenuifolia

Lianes
Flagellaria indica
Malaisia scandens

Sedges
Carex hattoriana

Ferns
Adiantum hispidulum
Nephrolepis cordifolia
Pteris microptera

INCLUSIONS: Cf, Cq, DaCt.

Relationship to other units: Closest to Cf and Cq.

Boundaries: Generally diffuse to Cf, Cq and DaCt.

OTHER DATA

A very mixed community without obvious dominants.
Stands may show single species dominance but these are not common.
Some mesic varieties occur, for example, between Red Ground and Boat Harbour.
The isolated stand near Neds Beach is remarkable for being on calcarenite.
The reason is unknown.

Sites: 4, 6, 9, 13, 14, 20, 22, 28, 33, 35, 70.

FORMATION: Evergreen Closed Forest with closed lower layers

SUBFORMATION: Rainforest

Number: ?1D1.1

Alliance: CRYPTOCARYA GREGSONII

CRYPTOCARYA GREGSONII

Symbol: Cg

Area: 7 ha, 0.4%

Oliver equivalent: ?Mountain low forest *Notelaea quadristaminea [Chionanthus quadristamineus]* Association

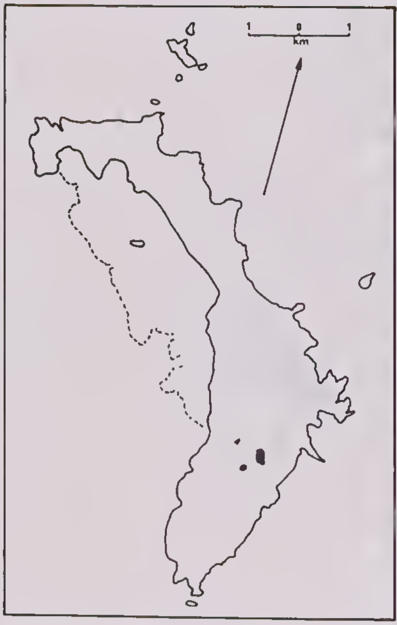
UNESCO equivalent: Subtropical ombrophhilous submontane forest 1A4.b

PHYSIOGRAPHY

Generalized site description: Altitude 350–600 m; aspect E and W; slope 10°–15°; moderate to high exposure; slopes at foot of cliffs, top-slopes.

Geology: Basalt

Soil: Very stony, probably Uf



E side of Mount Lidgbird c.250 m N of the Tableland. Altitude 450 m.

STRUCTURE

Basal area: n.d.

Emergents: Nil

Canopy Height: 20 m

Surface: Uneven

Cover: Mid-dense to sparse

Strata number: 2

Boundaries: Sharp

Composition: Trees, herbs. Small trees and shrubs not common.

Ground vegetation (<1 m)

Density: Variable

Composition: Ferns, herbs, sedges; dependent upon disturbance.

Special life-forms: Thick lianes common, tree-ferns occasional.

STRUCTURAL FEATURES OF CANOPY PLANTS   Life-form: Tree

Crown density: Mid-dense   Shape: Round   Branch position: Upper third and half
Type: Divergent   Stem: Leaning

Bark: Smooth   Roots: Spurs and surface spreading

Leaf size: Noto-microphyll   Shape: Broad   Margin: Entire
Texture: Sclerophyll

Large fruits common.

DISTURBANCE   Agent: Pigs

Degree: Moderate to severe

Location: Fern Patches, near the Tableland.

Pigs rooting for rhizomes and roots leave the soil surface bare or greatly denuded. Introduced plants (especially *Ageratina adenophora*) are locally common.

FLORISTICS (common species only)

Trees
Cryptocarya gregsonii
Dracophyllum fitzgeraldii
Euodia polybotrya
Hedyscepe canterburyana
Symplocos candelabrum

Shrubs/Woody herbs
Macropiper excelsum
var. *psittacorum*

Lianes
Malaisia scandens

Herbs
**Ageratina adenophora*
**Gnaphalium* spp.

Sedges
Carex hattoriana

Ferns
Pteris microptera

INCLUSIONS: Possibly some DfMn

Relationship to other units: Closest to DfMn of which it may be only a taller, more open phase.

Boundaries: Diffuse to DfMn.

OTHER DATA

This unit often occurs as open forest, for example, top of Fern Patches, E of Mount Lidgbird. The stand on the southern spur of Mount Lidgbird is different from all others — the soil is not stony and is heavily burrowed by Providence Petrels (*Pterodroma solandri*).

Sites: Nil.

FORMATION: Evergreen Closed Forest

SUBFORMATION: Broad Orthophyll Swamp Forest

Number: 1A1.2a

Alliance: LAGUNARIA

LAGUNARIA PATERSONIA

Symbol: Lp

Area: 6 ha, 0.4%

Oliver equivalent: Nil (Coastal scrub *Lagunaria patersonia* Association is not equivalent)

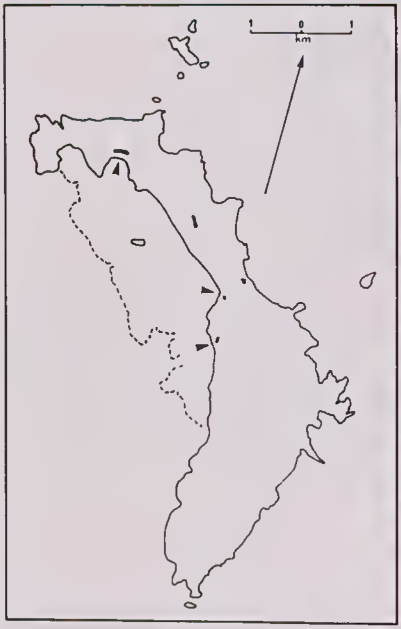
UNESCO equivalent: Broad-leaved subtropical ombrophilous swamp forest IA4.g1.

PHYSIOGRAPHY

Generalized site description: Altitude 0–20 m; nil aspect although maybe S and W; nil slope; very low exposure; valley bottom and depressions.

Geology: Calcarenite

Soil:Unknown, drainage impeded. Clay subsoil in some sites. May be in brackish waters.



E edge of Moseley Park showing ephemeral standing water. Altitude c.1 m. (Destroyed 1975 after construction of airport, see Figure 44).

STRUCTURE

Emergents: Nil

Canopy Height: 10 m
Cover: Dense
Composition: Trees, herbs.

Ground vegetation (<1 m)
Composition: Herbs, grasses.

Special life-forms: Occasional palms.

Basal area: 1350 sq m/ha

Surface: Even
Strata number: 2

Boundaries: Sharp

Density: Mid-dense

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Dense
Type: Divergent

Shape: Round
Stem: Straight

Branch position: More than half

Bark: Rough, flaky

Roots: Slight spurs

Leaf size: Microphyll
Texture: Orthophyll
Leaves tomentose

Shape: Broad

Margin: Entire

DISTURBANCE

Agent: Man

Degree: Partial and complete clearing

Location: All stands.

Grazing in all stands probably restricts seedling growth but it is doubtful if any stand could successfully regenerate.

FLORISTICS (common species only)

Trees
Hibiscus tiliaceus
Lagunaria patersonia

Grasses
**Axonopus compressus*
**Paspalum dilatatum*

INCLUSIONS: Nil

Relationship to other units: Not close to any unit.

Boundaries: Diffuse to Ac, Pf and DaCt, sharp to Hf and Cf.

OTHER DATA

Although *Lagunaria* is common (as individuals) on exposed cliffs it does not form communities except as swamp forest and these have been destroyed by clearing and grazing.

Sites: Nil

Photograph: 44.

FORMATION: Evergreen Closed Forest

SUBFORMATION: Megaphyllous Broad Sclerophyll Forest

Number: 1A1.6b

Alliance: HOWEA

HOWEA FORSTERIANA

Symbol: Hf

Area: 170 ha, 11.2%

Oliver equivalent: Lowland high and low forest *Howea Forsteriana [H. forsterana]* Association

UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4.a

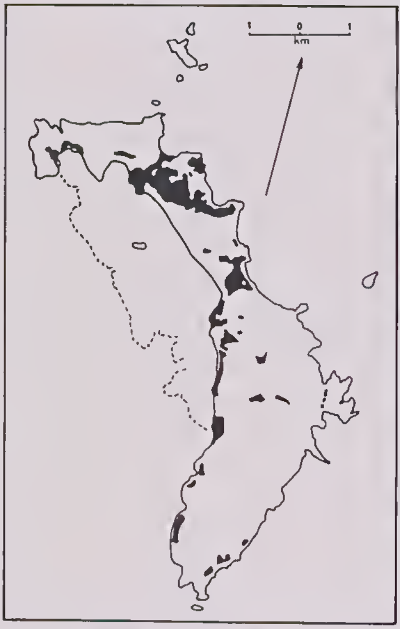
PHYSIOGRAPHY

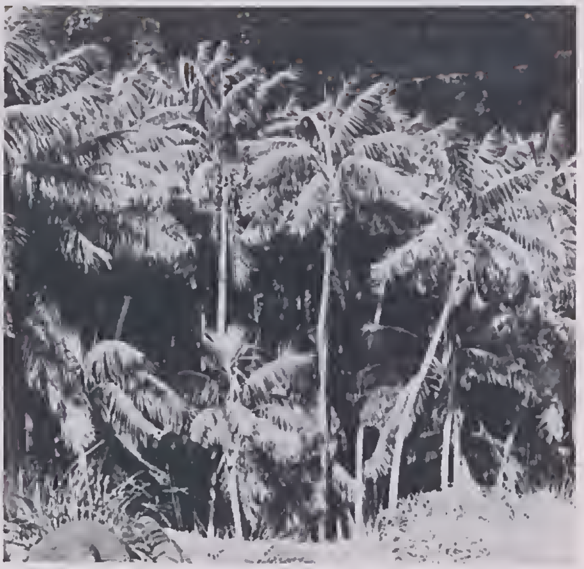
Generalized site description: Altitude 0–360 m, generally <120 m; all aspects: slope 0°–40° but generally <15°; exposure variable: flats, toe-, mid- and upper-slopes.

Geology: Calcarenite, recent coral

Soil: Variable

Other: Sand and basalt.





Near Little Island, beneath Mount Lidgbird. Altitude c.2 m.

STRUCTURE

Emergents Height: 15–25 m

Canopy Height: 10–20 m
Cover: Dense
Composition: Trees, small trees, herbs.

Ground vegetation (<1 m)
Composition: Ferns, sedges, creepers.

Special life-forms: Slender, wiry lianes occasional.

Basal area: 718 sq m/ha

Distribution: Patches

Surface: Uneven-smooth

Strata number: 2–3

Boundaries: Sharp

Density: 1770 palms/ha

STRUCTURAL FEATURES OF CANOPY PLANTS		Life-form: Tree
Crown density: Dense Type: n.a.	Shape: Round Stem: Straight, often leaning	Branch position: n.a.
Bark: Smooth, glassy to smooth, fine cracks	Roots: Slight swelling	
Leaf size: Megaphyll Texture: Sclerophyll	Shape: Deeply divided	Margin: —

DISTURBANCE Agent: Man, cattle

Degree: Severe

Location: Many stands north of Salmon Beach.

Cattle prevent regeneration by eating young palms.

FLORISTICS (common species only)

Trees
Cryptocarya triplinervis
Drypetes australasica
Ficus columnaris
Howea forsterana
Pandanus forsteri

Small trees
Coprosma putida
Elaeodendron curtipendulum
Myoporum insulare
Omalanthus populifolius
Randia stipulosa

Lianes
Flagellaria indica
Smilax australis

Twiners
Ipomoea cairica

Grasses & Sedges
Carex hattoriana
Oplismenus imbecillus

Ferns
Asplenium oblongifolium
Pteris microptera

INCLUSIONS: Pf, DaCt, Hb, and Cf.

Relationship to other units: Structurally similar to Hb and to a lesser extent Hc; floristically to none although understorey is similar to that of other lowland units, for example, DaCt.

Boundaries: Variable, sharp in places with DaCt but also diffuse in other places.

OTHER DATA

Range of basal area: 350–1000 sqm/ha
Range of density: 1140–2370 palms/ha
As this unit is very variable, the values of the parameters and descriptors may not be typical of individual stands.
Dominant unit on calcarenite, although DaCt also occurs here.
Ficus columnaris occurs as dome-like emergent. As an individual covers a considerable area, it can contribute significantly to total cover of a stand.

Sites: 51, 62, 66.

Disturbed Sites: 29, 31, 56, 57, 58, 64, 69.

Photographs: 22, 23, 26, 32, 35, 38, 48.

FORMATION: Evergreen Closed Forest

SUBFORMATION: Megaphyllous Broad Sclerophyll Forest

Number: IA1.6b

Alliance: HOWEA

HOWEA BELMOREANA

Symbol: Hb

Area: 75 ha, 5.0%

Oliver equivalent: Upland high forest *Howea Belmoreana [Howea belmoreana]*

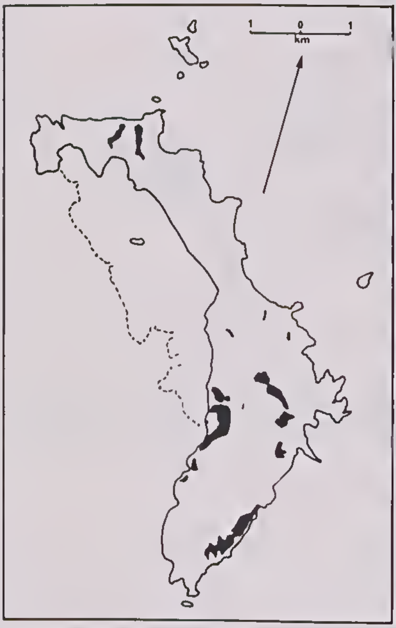
UNESCO equivalent: Subtropical ombrophilous lowland forest IA4.a

PHYSIOGRAPHY

Generalized site description: Altitude 5–250 m; all aspects; slopes 10°–30°; low exposure; mid-slopes and gullies.

Geology: Basalt, rarely calcarenite or recent coral sand

Soil: Stony, often on virtual scree



Willies Road, on Far Flats.
Altitude c.100 m.

STRUCTURE

Basal area: 773 sq m/ha

Emergents: Nil

Canopy Height: 12 m

Cover: Dense

Surface: Even

Strata number: 2

Boundaries: Sharp

Composition: Trees, herbs. Small trees present but scattered.

Ground vegetation (<1 m)

Density: Sparse

Composition: Sedges, creepers.

Special life-forms: Banyans occasional; tree-ferns, lianes, epiphytes variable.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Dense
Type: n.a.
Shape: Conical
Stem: Straight, generally leaning
Branch position: n.a.

Bark: Smooth, glassy
Roots: Slight swelling

Leaf size: Megaphyll
Texture: Sclerophyll
Shape: Deeply divided
Margin: —

DISTURBANCE

Agent: Man, pigs, cattle

Degree: Low to severe

Location: Signal Point, Far Flats, Soldier Creek.

Small stands originally at Signal Point have been cleared. Cattle grazing prevents regeneration, pigs disturb soil surface.

FLORISTICS (common species only)

Trees
Chionanthus quadristamineus
Cleistocalyx fullagari
Drypetes australasica
Ficus columnaris
Howea belmoreana
Howea forsterana

Small trees
Bubbia howeana
Randia stipulosa

Ferns
Histiopteris incisa
Microsorium sp. aff. *diversifolium*
Pteris microptera

INCLUSIONS: Cq.

Relationship to other units: Structurally close to Hf and Hc; floristically closest to Cf or Cq.

Boundaries: Generally indistinct.

OTHER DATA

Sites: 1, 3, 5, 30.

Disturbed Sites: Nil.

FORMATION: Evergreen Closed Forest

SUBFORMATION: Megaphyllous Broad Sclerophyll Forest

Number: 1A1.6b

Alliance: HEDYSCEPE

HEDYSCEPE CANTERBURYANA

Symbol: Hc

Area: 25 ha, 1.6%

Oliver equivalent: Mountain low forest *Hedyscepe canterburyana* Association

UNESCO equivalent: Subtropical ombrophilous submontane forest 1A4.b

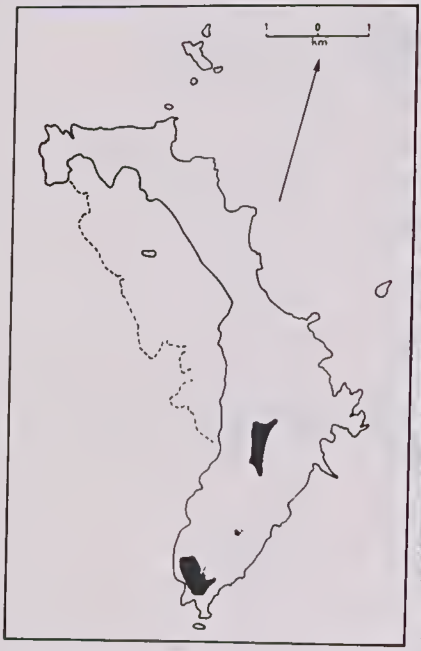
PHYSIOGRAPHY

Generalized site description: Altitude 335–830 m; generally >610 m; all aspects: slopes 15°–60° and cliffs; very exposed; top-slopes and benches.

Geology: Basalt

Soil: Unknown but stony. Probably always wet.

Other: Cloud and mist frequent.



Near summit Mount Lidgbird.
Altitude c.720 m.

STRUCTURE

Basal area: 1440 sq m/ha

Emergents Nil

Canopy Height: 8 m
Cover: Dense
Composition: Small trees, herbs.

Surface: Variable
Strata number: 2

Boundaries: Sharp

Ground vegetation (<1 m)
Composition: Herbs, twiners.

Density: Dense

Special life-forms: Tree-ferns common, epiphytes abundant; mosses and filmy ferns abundant.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Small tree

Crown density: Dense
Type: n.a.
Shape: Conical
Branch position: n.a.

Stem: Straight, leaning

Bark: Smooth
Roots: Slight swelling

Leaf size: Megaphyll
Texture: Sclerophyll
Shape: Deeply divided
Margin: —

DISTURBANCE

Agent: Birds (Providence Petrels, *Pterodroma solandri*)

Degree: Low to moderate

Location: All stands.

Burrowing by *Pterodroma solandri* probably causes mass movement of soil.

FLORISTICS (common species only)

Trees
Dracophyllum fitzgeraldii
Dysoxylum pachyphyllum
Hedyscepe canterburyana
Negria rhabdothamnoides
Pittosporum erioloma

Shrubs
Metrosideros villosa

Herbs
Elatostema reticulatum var. *grande*
Hydrocotyle javanica
Macropiper excelsum var. *psittacorum*

Sedges
Machaerina insularis
Uncinia debilior

Ferns
Blechnum spp.
Cyathea spp.
Diplazium melanochlamys
Grammitis spp.
Polystichum whiteleggei

Mosses abundant

INCLUSIONS: Cliff, BhDf, DfMn, BcMep

Relationship to other units: Structurally similar to Hb; floristically similar to BcMep and other montane units.

Boundaries: Diffuse to all adjacent units except dry cliffs.

OTHER DATA

Stems often bent at base, probably because of soil mass movement.

Sites: Nil.

Disturbed Sites: Nil.

FORMATION: Evergreen Closed Forest

SUBFORMATION: Megaphyllous Broad
Sclerophyll Forest

Number: 1A1.6b

Alliance: PANDANUS

PANDANUS FORSTERI

Symbol: Pf

Area: 19 ha, 1.2%

Oliver equivalent: Mountain low forest *Pandanus forsteri* Association

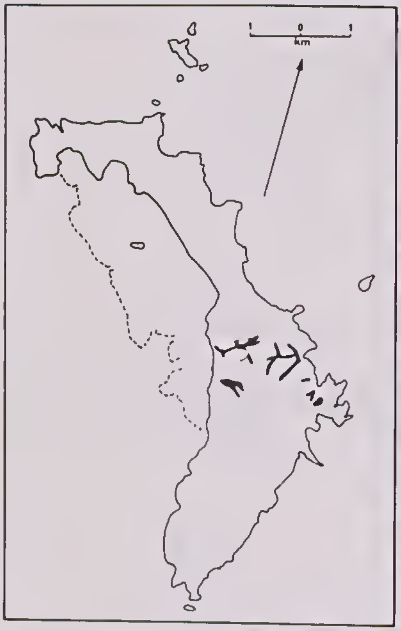
UNESCO equivalent: Subtropical ombrophilous lowland forest 1A4.a
Subtropical ombrophilous swamp forest 1A4.g

PHYSIOGRAPHY

Generalized site description: Altitude 0–150 m; aspect variable, often nil; slope variable 0°–20°, or steeper on some sites; low exposure; depressions, valley bottoms and gullies.

Geology: Basalt

Soil: Poorly drained, often flooded but not essential. Some stands on steep slopes (>10°) without impeded drainage.



Soldier or Big Creek, south of Peach Tree Ridge.
Altitude c.3 m.

STRUCTURE

Basal area: n.d.

Emergents Nil

Canopy Height: 15 m
Cover: Dense

Surface: Even or uneven
Strata number: 2

Boundaries: Sharp

Composition: Pandans and miscellaneous herbs, twiners.

Ground vegetation (<1 m)
Composition: Sedges

Density: Sparse

Special life-forms: Vascular epiphytes may be very large and prominent. In pure monotypic stands the ground is littered with fallen leaves and there is no ground vegetation.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tree

Crown density: Mid-dense
Shape: Round
Branch position: Upper half
Type: Divergent
Stem: Erect, straight

Bark: Smooth, small spikes
Roots: Stilt

Leaf size: Megaphyll
Shape: Narrow
Margin: Toothed
Texture: Sclerophyll

DISTURBANCE

Agent: Man, cattle

Degree: Variable, low to complete

Location: Soldier or Big Creek and tributaries, Rocky Run.

Some pig damage in places; Rocky Run, Erskine Valley (small unmapped stands).

FLORISTICS (common species only)

Trees
Chionanthus quadristamineus
Cleistocalyx fullagari
Drypetes australasica
Howea belmoreana
Howea forsterana
Pandanus forsteri

Small trees
Bubbia howeana
Euodia polybotrya
Randia stipulosa

Lianes
Flagellaria indica

Ferns
Microsorium sp. aff. *diversifolium*
Platycerium bifurcatum
Pteris microptera

INCLUSIONS: Nil.

Relationship to other units: Close to Hb and often merges with it. It is a somewhat unsatisfactory unit but at its optimal development (Soldier or Big Creek, Rocky Run) it is worth regarding as a distinct unit.

Boundaries: Diffuse generally.

OTHER DATA

Pandanus forsteri occurs in communities (Pf) along creeks, and as individuals over most of the basaltic soils (except for some areas, notably BhDf). Individuals on slopes in rocky soils and on cliffs are at variance with the occurrence of Pf communities in creeks and swampy depressions. The reason is unknown.

Sites: 27, 37, 41, 48.

Disturbed Sites: 40.

FORMATION: Evergreen Closed Forest SUBFORMATION: Gnarled Mossy Forest

Number 1A1.3a Alliance: BUBBIA-DRACOPHYLLUM

BUBBIA HOWEANA-DRACOPHYLLUM FITZGERALDII

Symbol: BhDf Area: 28 ha, 1.8%

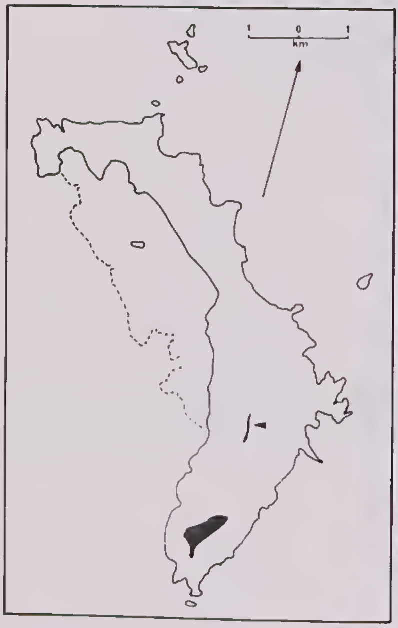
Oliver equivalent: Moss Forest *Dracophyllum fitzgeraldii-Clinostigma mooreanum [Lepidorrhachis mooreana]-Cyathea brevipinna*

UNESCO equivalent: Subtropical broad-leaved ombrophilous cloud forest 1A4.e1.

PHYSIOGRAPHY

Generalized site description: Altitude > 750 m; aspect variable; slope usually low, but up to 45°; exposure low to very high, especially on cliff edges; on summit — both razor and broad-flat.

Geology: Basalt Soil: Poorly developed over deeply weathered basalt. Usually above field capacity.



Summit ridge of Mount Lidgbird.
Altitude 760 m.

STRUCTURE Basal area: n.d.

Emergents Nil

Canopy Height: 5 m Surface: Very smooth
Cover: Very dense Strata number: 3 Boundaries: Diffuse
Composition: Small trees, shrubs and tree-ferns, herbs and ferns.

Ground vegetation (<1 m) Density: Dense
Composition: Herbs, ferns, mosses.

Special life-forms: Non-vascular epiphytes abundant; lianes rare; large tussock sedges common; tree-ferns common.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Small tree

Crown density: Dense
Shape: Flat
Branch position: More than half
Type: Divergent
Stem: Crooked, bent and branchy
Bark: Variable
Leaf size: Nano- and notophyll
Roots: Normal, surface spreading
Texture: Sclero- and orthophyll
Shape: Broad
Margin: Entire

DISTURBANCE

Agent: Birds (see text)
Degree: Locally severe
Location: Entire unit

The birds, Providence Petrels (*Pterodroma solandri*), burrow and disturb the soil. The effects are not known. Feral rats (*Rattus rattus*) are abundant and eat seeds and leaf rachises.

FLORISTICS (common species only)

Small trees
Bubbia howeana
Dracophyllum fitzgeraldii
Elaeocarpus costatus
Hedyscepe canterburyana
Lepidorrhachis mooreana
Leptospermum flavescens
Negria rhabdothamnoides
Symplocos candelabrum

Shrubs
Dysoxylum pachyphyllum
Olearia mooneyi

Herbs
Elatostema reticulatum

Sedges
Gahnia xanthocarpa
Machaerina insularis

Ferns
Blechnum spp.
Cyathea spp.
Diplazium melanochlamys
Grammitis spp.
Microsorium spp.
Polystichum whiteleggei

Mosses, lichens and filmy ferns abundant

INCLUSIONS: Cliff, Hc.

Relationship to other units: Structurally quite distinct; floristically distinct but close to Hc and DfMn.

Boundaries: Merges with Hc and Cliff.

OTHER DATA

The BhDf on Mount Lidgird is an attenuated exposed form but is within the range of variation of the unit.
Floristically complex with a high number of species.
BhDf is variable in structure—depending upon site, for example, on edges of small cliffs it becomes lower, scrubbier and more open.
Mist abundant. Never below 750 m altitude.

Sites: Nil.

FORMATION: Closed Evergreen Scrub SUBFORMATION: Broad Orthophyll Scrub
Number: IB1.1a Alliance: BOEHMERIA-MACROPIPER

BOEHMERIA CALOPHLEBA-MACROPIPER EXCELSUM VAR. *PSITTACORUM*

Symbol: BcMep Area: 3 ha, 0.2%

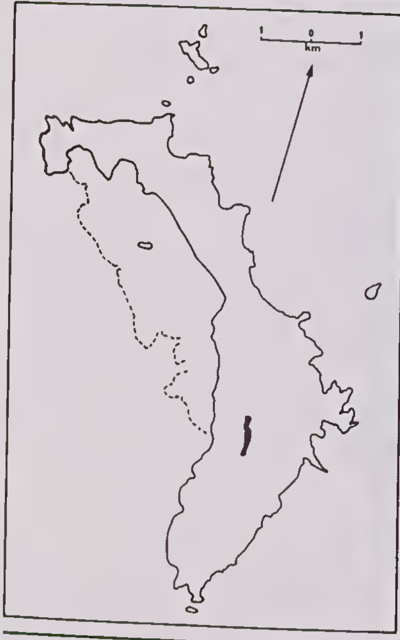
Oliver equivalent: Nil

UNESCO equivalent: Evergreen broad-leaved hemi-sclerophyllous thicket IIIA1.c;
Evergreen suffruticose thicket IIIA1.e.

PHYSIOGRAPHY

Generalized site description: Altitude 530 m; N and W aspects; slopes 10°- 60°, including small cliffs; exposure moderate to high; mid-slopes, on terrace between cliffs.

Geology: Basalt Soil: Stony, probably always very wet.



Terrace above Black Face, Mount Lidgbird.
Altitude 530 m.

STRUCTURE

Emergents Height: 4-5 m

Canopy Height: 3-4 m
Cover: Closed
Composition: Shrubs and herbs.

Ground vegetation (<1 m) Density: Sparse
Composition: Ferns, broad-leaved sedges and herbs.

Basal area: n.a.

Distribution: Scattered or in patches

Surface: Even-uneven
Strata number: 2 Boundaries: Diffuse-sharp

Special life-forms: Semi-succulent herbs abundant; epiphytes not common; tree-ferns abundant, particularly as emergents.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Dense
Shape: Round
Branch position: Base
Type: Divergent
Stem: Branchy, crooked

Bark: Smooth
Roots: Normal, or surface

Leaf size: Noto- and megaphyll
Shape: Broad
Margin: Entire
Texture: Orthophyll colour, many stems pithy

Leaves are generally light green.

DISTURBANCE

Agent: Birds, (see text)

Degree: Moderate to low, locally severe

Location: Entire unit.

The Providence Petrel (*Pterodroma solandri*) nests on the terrace. Disturbance is generally low and restricted to burrowing, digging and defaecation.

FLORISTICS (common species only)

Small trees and shrubs
Boehmeria calophleba
Hedyscepe canterburyana
Macropiper excelsum var. *psittacorum*
Negria rhabdothamnoides
Pittosporum erioloma

Herbs
Elatostema reticulatum var. *grande*

Sedges
Gahnia xanthocarpa
Machaerina insularis

Ferns
Cyathea spp.
Histiopteris incisa
Pteris microptera

INCLUSIONS: Hc, Cliff, DfMn.

Relationship to other units: The unit does not appear to be closely related to any other.

Boundaries: Diffuse to Hc, Cliff, and some BhDf.

OTHER DATA

Very restricted on the island. This may reflect either disturbance by feral goats and pigs in other places or lack of suitable sites.
An unmapped stand of *Gahnia xanthocarpa* on the terrace above the Round Face of Mount Lidgbird is included in this unit. It most closely resembles Cl but is floristically distinct.
Cloud cover high.

Sites: Nil.

FORMATION: Closed Evergreen Scrub

SUBFORMATION: Broad Sclerophyll Swamp Scrub

Number: 1B1.3c

Alliance: AEGICERAS

AEGICERAS CORNICULATA

Symbol: Ac

Area: 2 ha, 0.1%

Oliver equivalent: Mangrove *Aegiceras corniculata* Association

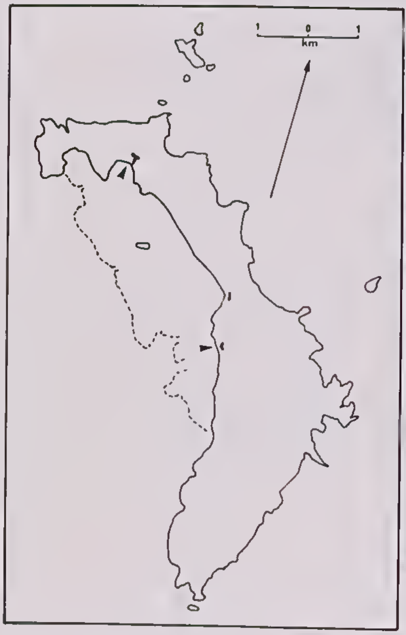
UNESCO equivalent: Evergreen broad-leaved sclerophyllous thicket IIIA1.d

PHYSIOGRAPHY

Generalized site description: Altitude 0 m; aspect nil; slope <1°; exposure low to moderate; estuarine flats flooded at high tide.

Geology: Not known, ?sand

Soil: Slaked soil, high NaCl (inferred), drainage poor.



Creek at S end Prince William Henry Bay. Altitude 0 m.

STRUCTURE

Basal area: n.d.

Emergents Nil.

Canopy Height: 4.5 m
Cover: Dense
Composition: Shrubs, herbs.

Surface: Even-uneven
Strata number: 2

Boundaries: Sharp

Ground vegetation: (<1 m)
Composition: Succulent herbs.

Density: Sparse-Nil

Special life-forms: Probably algae on soil surface.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Dense
Type: Divergent

Shape: Round
Stem: Crooked, branchy

Branch position: Base

Bark: Smooth

Roots: Normal

Leaf size: Microphyll
Texture: Sclerophyll

Shape: Broad

Margin: Entire

Pneumatophores rare in undisturbed stands

DISTURBANCE

Agent: Man, cattle

Degree: Low to severe

Location: Old Settlement Beach, Soldier or Big Creek.

FLORISTICS (common species only)

Small trees
Aegiceras corniculata
Lagunaria patersonia

Herbs
Sarcocornia quinqueflora
Triglochin striatum

INCLUSIONS: Nil

Relationship to other units: Not closely related to any unit although it probably merges with Lp.

Boundaries: Sharp except with Lp.

OTHER DATA

This unit is gradually becoming more restricted on the island. Continued clearing and grazing in the remaining stands will probably cause the extinction of the species on the island. The least-disturbed stand appears to be that at the southwest corner of Moseley Park. There is no intact stand of large plants.

Sites: Nil

FORMATION: Closed Evergreen Scrub

SUBFORMATION: Evergreen Broad Sclerophyll Scrub

Number: 1B1.4a

Alliance: DODONAEA

DODONAEA VISCOSA

Symbol: Dv

Area: 9 ha, 0.6%

Oliver equivalent: Hill scrub *Dodonaea viscosa* Assocation

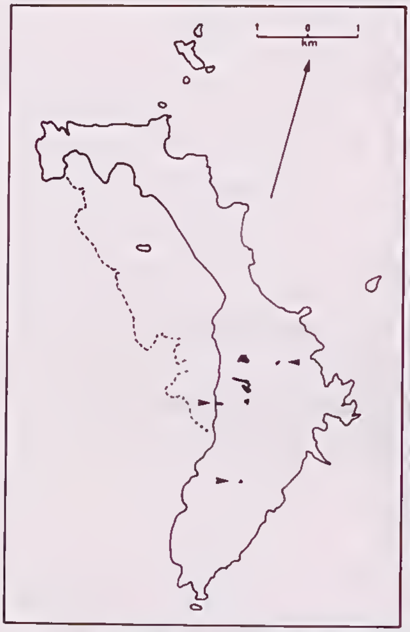
UNESCO equivalent: Evergreen broad-leaved sclerophyllous thicket IIIA1.d

PHYSIOGRAPHY

Generalized site description: Altitude 30–300 m; aspect variable, generally N; slope low-high 5°–25°; exposure low-extreme; mid-slopes and summits of ridges.

Geology: Basalt

Soil: Unknown



Portion 130, S of "Mountain Inn".
Altitude 60 m.

STRUCTURE

Basal area: n.d.

Emergents Nil.

Canopy Height: 5 m
Cover: Complete
Composition: Shrubs, half-shrubs, herbs.

Surface: Even-uneven
Strata number: 2

Boundaries: Diffuse

Ground vegetation (<1 m)
Composition: Herbs, sedges.

Density: Dense

Special life-forms: Lianes abundant in light breaks.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Sparse
Type: Divergent

Shape: Round
Branch position: Base
Stem: Crooked, branchy

Bark: Slightly fibrous

Roots: Surface, normal

Leaf size: Mesophyll
Texture: Sclerophyll

Shape: Broad
Margin: Entire

DISTURBANCE

Agent: Man, cattle

Degree: Low to severe

Location: Portion 130, on ridge S of "Mountain Inn".

Clearing for grazing.

FLORISTICS (common species only)

Shrubs
Cassinia tenuifolia
Dodonaea viscosa
Guioa coriacea
Howea forsterana
Polyscias cissodendron

Lianes
Smilax australis

Herbs
**Ageratina adenophora*

Sedges
Carex hattoriana
Scirpus nodosus

INCLUSIONS: Nil.

Relationship to other units: —

Boundaries: Diffuse to DaCt, Cliff.

OTHER DATA

Stand below Grey Face is very exposed and stunted compared with others. The site is very stony. It can be seen at the immediate foot of the Grey Face in the photograph under "Cliff". (p.216).
The unit may be seral in some stands which occur in slump scars on spurs at the western foot of Nobbin.

Site: 44.

Disturbed sites: Nil.

Photograph: 27.

FORMATION: Closed Evergreen Scrub

SUBFORMATION: Evergreen Broad Sclerophyll Scrub

Number: 1B1.4a

Alliance: DRACOPHYLLUM-METROSIDEROS

DRACOPHYLLUM FITZGERALDII-METROSIDEROS NERVULOSA

Symbol: DfMn

Area: 45 ha, 2.9%

Oliver equivalent: Nil

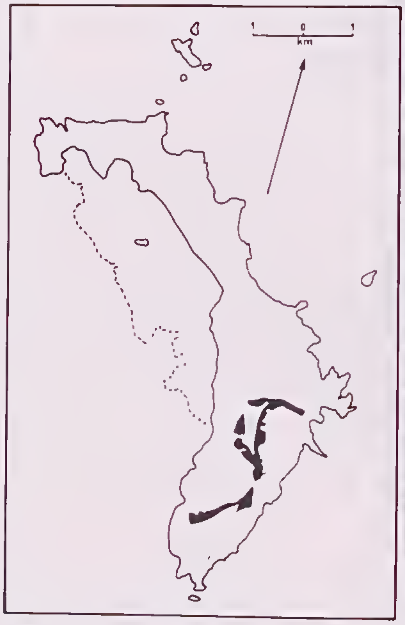
UNESCO equivalent: Evergreen broad-leaved sclerophyll shrubland (or thicket) IIIA1.d

PHYSIOGRAPHY

Generalized site description: Altitude 340–610 m but generally between 380–530 m; all aspects, slope 10°–60°; exposure moderate to high; top slopes and benches on cliffs.

Geology: —

Soil: —



Below and E of the Tableland.
Altitude 450 m.

STRUCTURE

Basal area: n.d.

Emergents Nil

Canopy Height: 4–6.5 m

Cover: Variable

Surface: Uneven-smooth

Strata number: 3

Boundaries: Diffuse-sharp

Composition: Trees, small trees, shrubs, herbs.

Ground vegetation (<1 m)

Density: Variable

Composition: Ferns, sedges, creepers.

Special life-forms: Tree-ferns abundant, palms occasional, mossy epiphytes may be abundant.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Small trees, shrubs

Crown density: Dense-mid-dense
Shape: Round-flat
Branch position: About half to base
Type: Divergent and horizontal
Stem: Leaning, crooked, branchy

Bark: Rough
Roots: Some spurs

Leaf size: Nano-to macrophyll
Shape: Variable
Margin: Variable
Texture: Variable

Extremely variable

DISTURBANCE

Agent: Goats, pigs

Degree: Moderate

Location: Most stands.

Browsing by goats; spread of naturalized plants. Rooting of pigs, exposing soil.

FLORISTICS (common species only)

Shrubs and small trees
Carmichaelia exsul
Cassinia tenuifolia
Chionanthus quadristamineus
Cryptocarya gregsonii
Dracophyllum fitzgeraldii
Drypetes australasica
Euodia polybotrya
Hedyscepe canterburyana
Leptospermum flavescens
Metrosideros nervulosa
Olearia ballii
Symplocos candelabrum

Herbs
Brachycome segmentosa
Plantago hedleyi

Ferns
Blechnum capense
Cyathea spp.
Histiopteris incisa
Pteris microptera

INCLUSIONS: Cliff, Cg, Hc, Cq, MFH.

Relationship to other units: Uncertain.

Boundaries: Diffuse to most adjacent units except Cliff.

OTHER DATA

This is an extremely variable unit and values for descriptors may not be applicable to individual sites. The stands vary enormously: on one spur there may be mesic DfMn whereas the next spur may support a more sclerophyllous and open DfMn.

Sites: 10, 17.

Disturbed sites: Nil.

FORMATION: Closed Evergreen
Sclerophyll Scrub/Green
Microphyllous Evergreen Scrub

Number: 1B1.7/1B1.8a

SUBFORMATION: Straight Narrow
Sclerophyll Scrub

Alliance: MELALEUCA-CASSINIA

MELALEUCA HOWEANA

Symbol: Mh

Area: 42 ha, 2.8%

Oliver equivalent: Coastal scrub *Melaleuca ericifolia [Melaleuca howeana]* Association.

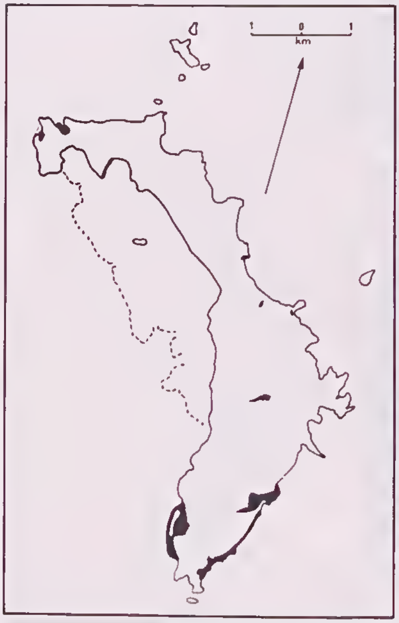
UNESCO equivalent: Evergreen microphyllous thicket (or shrubland) IIIA2.b

PHYSIOGRAPHY

Generalized site description: Altitude 0–500 m, generally <150 m; all aspects; slope 5°– 90°, generally 15° - 40°; moderately to extremely exposed; top slopes, ridge crests, terraces on cliffs.

Geology: Basalt, calcarenite

Soil: Unknown, often very stony



N end of Blinky Beach.
Altitude 5 m.

STRUCTURE

Emergents Height: 5 m

Canopy Height: 1.5–4 m
Cover: Dense
Composition: Shrubs and herbs.

Ground vegetation (<1 m)
Composition: Herbs, sedges, creepers.

Special life-forms: Palms rare.

Basal area: n.a.

Distribution: Scattered

Surface: Even-uneven
Strata number: 2

Boundaries: Sharp

Density: Variable, zero to dense

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Dense
Shape: Round
Branch position: Base
Type: Divergent
Stem: Branchy

Bark: Flaky
Roots: Normal

Leaf size: Nanophyll
Shape: Linear
Margin: Entire
Texture: Sclerophyll

DISTURBANCE

Agent: Goats

Degree: Low to moderate

Location: Virtually all stands.

Effect appears to be limited to some opening-up of scrub and introduction of naturalized plants.

FLORISTICS (common species only)

Trees
Howea belmoreana
Lagunaria patersonia

Shrubs
Alyxia ruscifolia
Cassinia tenuifolia
Melaleuca howeana
Westringia fruticosa

Twiners
Commelina cyanea
Hydrocotyle javanica
Melanthera biflora
Muehlenbeckia complexa

Grasses & Sedges
Cyperus lucidus
Poa poiformis
Scirpus nodosus
Sporobolus virginicus

Ferns
Adiantum hispidulum
Asplenium oblongifolium

INCLUSIONS: Cliff, Ca, DaCtX, MFH, Pp.

Relationship to other units: Very close to Ca.

Boundaries: Diffuse to most adjoining units.

OTHER DATA

Some stands, for example, Old Gulch, are composed of bigger than average shrubs.
Stand at northern end of Little Slope is secondary after goat grazing.
As this unit occurs over a wide altitudinal and environmental range, the values of parameters and descriptors given here may not be typical of individual stands.
Stands generally appear dark green.
Some low altitude sites are very exposed to salt spray.

Sites: 13, 50, 52.

Disturbed sites: Nil.

Photograph: 25.

FORMATION: Closed Evergreen Sclerophyll Scrub/Green Microphyllous Evergreen Scrub
SUBFORMATION: Straight Narrow Sclerophyll Scrub
Number: 1B1.7/1B1.8a
Alliance: MELALEUCA-CASSINIA

CASSINIA TENUIFOLIA

Symbol: Ca
Area: 29 ha, 1.9%

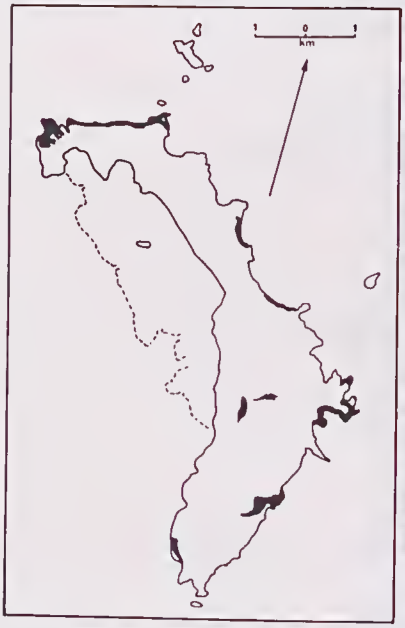
Oliver equivalent: Coastal scrub *Cassinia tenuifolia* Association.

UNESCO equivalent: Evergreen microphyllous thicket (or shrubland) IIIA2.b

PHYSIOGRAPHY

Generalized site description: Altitude 0–490 m, generally <150 m; all aspects; slope 5°– 90°, generally >30°; very exposed; top slopes, ridge crests and terraces on cliffs.

Geology: Basalt
Soil: Stony, skeletal



S ridge of Mount Eliza.
Altitude 100 m.

STRUCTURE

Emergents Height: up to 5 m

Canopy Height: 1–2 m
Cover: Dense-open
Composition: Shrubs and herbs.

Ground vegetation (<1 m)
Composition: Sedges, herbs and creepers.

Special life-forms: Palms rare; slender wiry lianes rare.

Basal area: n.a.

Distribution: Scattered

Surface: Uneven
Strata number: 2

Boundaries: Sharp

Density: Variable

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Dense
Shape: Round
Branch position: Base
Type: Divergent
Stem: Branchy

Bark: Flaky
Roots: Surface spreading and normal

Leaf size: Nanophyll
Shape: Linear
Margin: Entire
Texture: Sclerophyll

DISTURBANCE

Agent: Goats

Degree: Moderate, locally severe

Location: All stands.

Locally the effect of goat camps is complete denudation, but generally the goats only thin the scrub canopy and this is followed by establishment of naturalized plants.

FLORISTICS (common species only)

Shrubs
Cassinia tenuifolia
Dodonaea viscosa
Drypetes australasica
Lagunaria patersonia
Melaleuca howeana
Pimelea congesta
Westringia fruticosa

Twiners
Muehlenbeckia complexa
Tylophora biglandulosa

Herbs
Peperomia tetraphylla

Grasses & Sedges
Cyperus lucidus
Poa poiformis
Scirpus nodosus

Ferns
Microsorium sp. aff. *diversifolium*

INCLUSIONS: Cliff, Mh, DaCtX, Pp.

Relationship to other units: Very close to Mh.

Boundaries: Generally diffuse to all adjoining communities.

OTHER DATA

Stands generally appear light blue or greyish.
Many naturalized species occur in some stands.

Sites: 16, 25, 61, 65.

Disturbed sites: Nil.

Photographs: 25, 26.

FORMATION: Dwarf Scrub
Number: IC1.2a

SUBFORMATION: Orthophyll Dwarf Scrub
Alliance: ATRIPLEX

ATRIPLEX CINEREA

Symbol: Ax

Area: 0.6 ha

Oliver equivalent: Nil

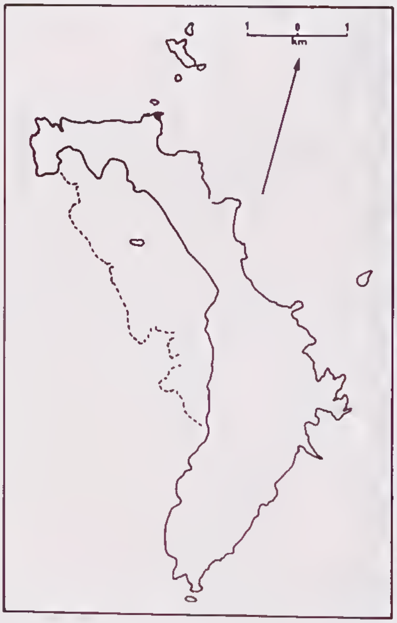
UNESCO equivalent: Evergreen caespitose dwarf-shrub thicket IVA1.a

PHYSIOGRAPHY

Generalized site description: Altitude 0–45 m; N aspect; slope 10°– 30°; very exposed; mid-slopes.

Geology: Recent coral sand over basalt

Soil: Sandy, minimal development, Uc



Spur below and NE of Malabar.
Altitude 10 m.

STRUCTURE

Emergents Nil

Canopy Height: 1 m
Cover: Dense
Composition: Dwarf shrubs, herbs.

Ground vegetation (<1 m)
Composition: Rhizomatous grasses.

Special life-forms: —

Basal area: n.a.

Surface: Smooth
Strata number: 2

Boundaries: Sharp

Density: Mid-dense to sparse

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Dwarf shrub

Crown densiy: Dense
Type: Divergent
Shape: Round
Stem: Branchy
Branch position: Base

Bark: —
Roots: ?

Leaf size: Microphyll
Texture: Orthophyll
Leaves with glandular hairs
Shape: Broad
Margin: Entire

DISTURBANCE

Agent: Birds (see text)

Degree: Low

Location: Malabar Point.

FLORISTICS (common species only)

Shrubs
Atriplex cinerea

Grasses
Sporobolus virginicus

INCLUSIONS: Nil.

Relationship to other units: Not closely related to any other unit on the island.

Boundaries: Sharp, due to erosion as shown in photograph.

OTHER DATA

The unit is restricted to talus debris piles below sea-cliffs, for example, Malabar and (unmapped) at Middle Beach.
Isolated individuals of *A. cinerea* occur sporadically in space and time on Old Settlement, North and Lagoon Beaches.

Site: 72.

Disturbed sites: Nil.

FORMATION: Broad-leaved Herb

SUBFORMATION: ?Evergreen Broad-leaved Weedy Vegetation

Number: ?1N1.1

Alliance: IPOMOEA-CARPOBROTUS

IPOMOEA CAIRICA-CARPOBROTUS GLAUCESCENS

Symbol: IcCg

Area: 5 ha, 0.3%

Oliver equivalent: ?Rushes *Ipomoea palmata [Ipomoea cairica]* Association.

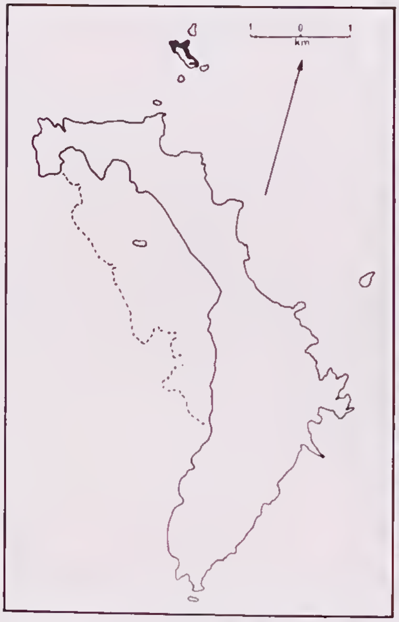
UNESCO equivalent: Perennial forb community VF1

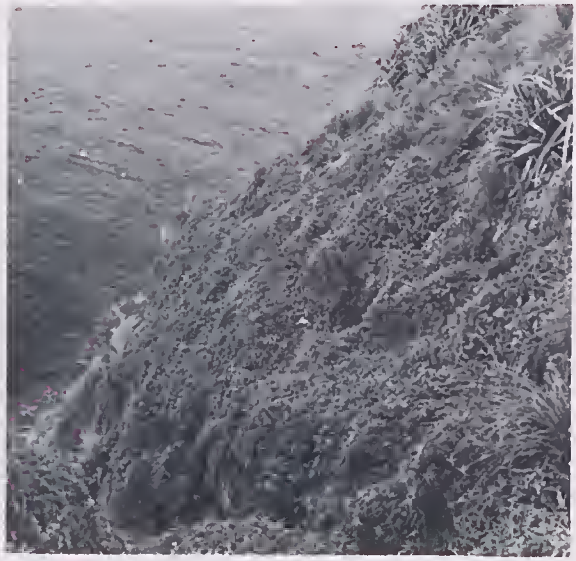
PHYSIOGRAPHY

Generalized site description: Altitude 0–85 m; all aspects; slopes moderate to high 10°– 60°; exposure very high to extreme; entire slope and ridge summit.

Geology: Basalt

Soil: Shallow, inferred high faecal nitrogen





NW spur of Roach Island.
Altitude 45 m.

STRUCTURE

Emergents Height: 1.5 m

Canopy Height: 0.3 m
Cover: Dense
Composition: Herbs and grasses.

Ground vegetation (<1 m)
Composition: —

Basal area: n.a.

Distribution: Patches, in lee of rocks

Surface: Uneven
Strata number: 1

Boundaries: —

Density: —

Special life-forms: Creepers abundant; succulent herbs abundant; ferns very rare.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Herb

Crown density: n.a.
Type: Horizontal
Shape: Creeper
Stem: —
Branch position: Creeper

Bark: —
Roots: —

Leaf size: —
Texture: Sclerophyll, succulent
Shape: Narrow
Margin: Entire and deeply lobed

DISTURBANCE

Agent: Birds (see text)

Degree: Locally severe

Location: Roach Island

Surface nesting and burrowing are ± equally common.

FLORISTICS (common species only)

Shrubs
Celtis amblyphylla
Drypetes australasica
Melaleuca howeana

Twiner
Ipomoea cairica

Herbs
Achyranthes aspera
Carpobrotus glaucescens
Commelina cyanea

Grasses & Sedges
Cyperus lucidus
Poa poiformis
Sporobolus virginicus

INCLUSIONS: Cliff, Cl, Mh, Pp.

Relationship to other units: Close to Pp, Cliff.

Boundaries: Merges with Cliff, Cl, Pp.

OTHER DATA

Sites: Nil.

Photographs: 18, 19.

FORMATION: Broad-leaved Herb

SUBFORMATION: ?Evergreen Broad-leaved Weedy Vegetation, Evergreen Fern Meadow

Number: 1N1.3

Alliance: —

MIXED FERN AND HERB

Symbol: MFH

Area: 7 ha, 0.3%

Oliver equivalent: Nil

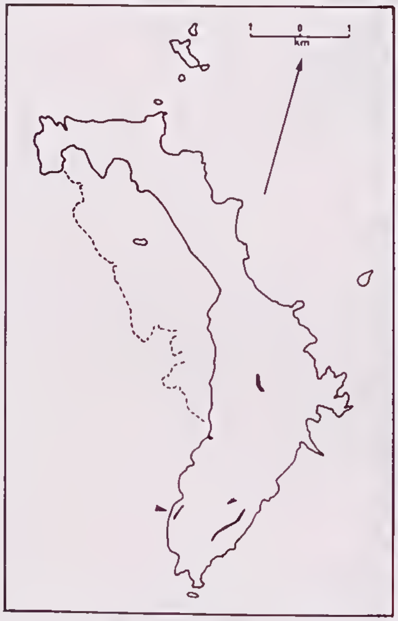
UNESCO equivalent: Perennial ruderal and clearing herb formation VF1.e

PHYSIOGRAPHY

Generalized site description: Altitude 80–500 m; aspect variable; slope usually moderate-steep 10°– 40°; exposure moderate to severe; top slopes, almost always at the foot of cliffs.

Geology: Basalt

Soil: Unknown. Stony.



Below Old Kings Cave, Mount Gower. Altitude 450 m.

STRUCTURE

Basal area: n.a.

Emergents Height: 4.5 m

Distribution: Patches

Canopy Height: 1.2 m
Cover: Dense-sparse
Composition: Herbs.

Surface: Uneven
Strata number: 1

Boundaries: —

Ground vegetation (<1 m)
Composition: —

Density: —

Special life-forms: Tree-ferns and palms occasional as emergents; ferns abundant; lianes rare.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: —

Crown density: —
Type: —
Shape: —
Stem: —
Branch position: —

Bark: —
Roots: —

Leaf size: —
Texture: —
Shape: —
Margin: —

Mostly n.a. due to nature of plants and lack of dominants.

DISTURBANCE

Agent: Pigs, goats

Degree: Low to severe

Location: Old Kings Cave.

FLORISTICS (common species only)

Small trees
Dracophyllum fitzgeraldii
Hedyscepe canterburyana

Herbs
**Bidens pilosa*
Elatostema reticulatum var. *grande*
**Ageratina adenophora*
Solanum spp.

Sedges
Carex hattoriana
Cyperus lucidus
Scirpus nodosus

Ferns
Adiantum hispidulum
Asplenium oblongifolium
Cyathea spp.
Histiopteris incisa
Pteris microptera

INCLUSIONS:—

Relationship to other units:—

Boundaries: Merges with all adjoining units especially MLM, Cq, Cliff, and Hf.

OTHER DATA

Many stands of MFH appear to be disturbed and this may indicate that the unit is seral. More detailed observations are necessary to clarify this point.

Sites: Nil.

FORMATION: Tall Grass
Number: 1L1.4

SUBFORMATION: Sclerophyll Tall Grass
Alliance: CYPERUS

CYPERUS LUCIDUS

Symbol: Cl

Area: 3 ha, 0.2%

Oliver equivalent: Tussock sedges *Mariscus haematodes [Cyperus lucidus]* Association

UNESCO equivalent: Tall grass steppe/with trees/with shrubs/without woody plants VB1.a/b/c

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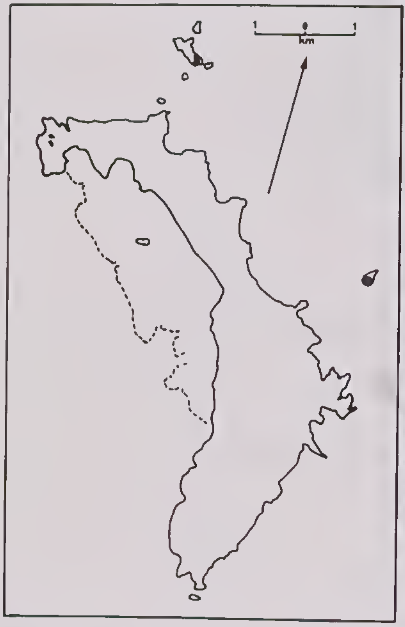
PHYSIOGRAPHY

Generalized site description: Altitude 0–70 m; aspect variable; slope low to high 5°–35°; exposure moderate-severe; entire slope and summit.

Geology: Basalt, recent coral sand

Soil: Unknown



SE spur of Roach Island.
Altitude 60 m.

STRUCTURE

Emergents Height: 15 m

Canopy Height: 1.0 m
Cover: Mid-dense
Composition: Tussock sedges, herbs.

Ground vegetation (<1 m)
Composition: —

Special life-forms: —

Basal area: n.a.

Distribution: Patches

Surface: Even
Strata number: 2

Boundaries: Sharp

Density: —

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Tussock sedge

Crown density: Sparse
Type: —
Shape: —
Stem: Rhizome
Branch position: —

Bark: —
Roots: —

Leaf size: Megaphyll
Texture: Sclerophyll
Shape: Narrow
Margin: Toothed, cutting

DISTURBANCE

Agent: Birds (see text)

Degree: Low to severe

Location: All stands.

FLORISTICS (common species only)

Twiners
Commelina cyanea
Ipomoea cairica

Grasses & Sedges
Cyperus lucidus
Phragmites australis
Poa poiformis
Sporobolus virginicus

Herbs
Crinum pedunculatum

INCLUSIONS

Relationship to other units:—

Boundaries: Merge with adjoining units.

OTHER DATA

An unmapped stand on scree near Little Island differs from others in terms of secondary characteristics such as emergent palms, and epiphytic ferns on rocks.
Other stands occur between beaches (usually boulder) and forest. These are basically similar to the described unit.
A further unmapped stand, of *Gahnia xanthocarpa*, on the terrace on Mount Lidgbird (elev. 530 m) is structurally very similar but floristically distinct.

Sites: Nil.

Photograph: 21.

FORMATION: Short Grass
Number: IM1.3

SUBFORMATION: Orthophyll Short Grass
Alliance: POA

POA POIFORMIS

Symbol: Pp

Area: 14 ha, 0.9%

Oliver equivalent: Rushes *Poa caespitosa [Poa poiformis]* Association

UNESCO equivalent: Mid grass steppe/with shrubs/without woody plants VB2. b/c

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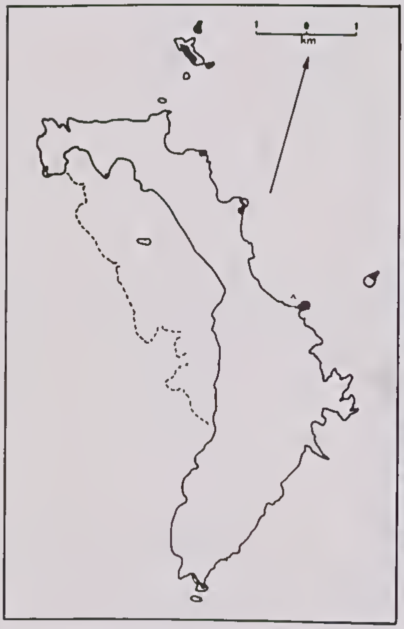
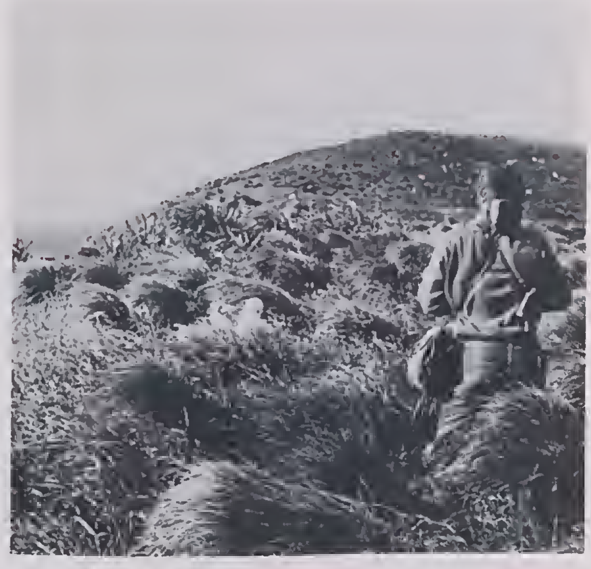
PHYSIOGRAPHY

Generalized site description: Altitude 10–70 m; all aspects; slope <10°; exposure very high; crests of rises, and terraces on cliffs.

Geology: Basalt

Soil: Unknown, stony, often shallow





Mutton Bird Point. Altitude 25 m.
(The man is kneeling, not standing)

STRUCTURE

Emergents Height: 2 m

Canopy Height: 0.5 m
Cover: Mid-dense
Composition: Tussock grass.

Ground vegetation (<1 m)
Composition: —

Special life-forms: Creepers common.

Basal area: n.a.

Distribution: Scattered

Surface: Uneven
Strata number: 1

Boundaries: —

Density: —

STRUCTURAL FEATURES OF CANOPY PLANTS		Life-form: Tussock grass
Crown density: Dense Type: —	Shape: Weeping Stem: —	Branch position: —
Bark: —	Roots: —	
Leaf size: — Texture: Orthophyll	Shape: Linear	Margin: Entire

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DISTURBANCE

Agent: Birds (see text)

Degree: Low to severe

Location: All stands.

FLORISTICS (common species only)

Shrubs
Cassinia tenuifolia
Melaleuca howeana

Twiners
Commelina cyanea
Ipomoea cairica

Grasses & Sedges
Cyperus lucidus
Poa poiformis
Scirpus nodosus

INCLUSIONS: Small areas, Cl, Cliff, Ca, Mh, DaCtX and IcCg.

Relationship to other units: Close to more open phases of Ca and Mh.

Boundaries: Merges with most adjoining units.

OTHER DATA

The stand at Mutton Bird Point is reported by some islanders to be secondary following destruction of DaCtX by browsing goats. There is no evidence to support this (Pickard, 1976).

Sites: Nil.

Photographs: 20, 25, 26.

FORMATION: Closed Submerged Meadow SUBFORMATION: Submerged Meadow

Number: IP1.1 Alliance: ZOSTERA-HALOPHILA

ZOSTERA CAPRICORNI—HALOPHILA OVALIS

Symbol: ZcHo Area: —

Oliver equivalent: —

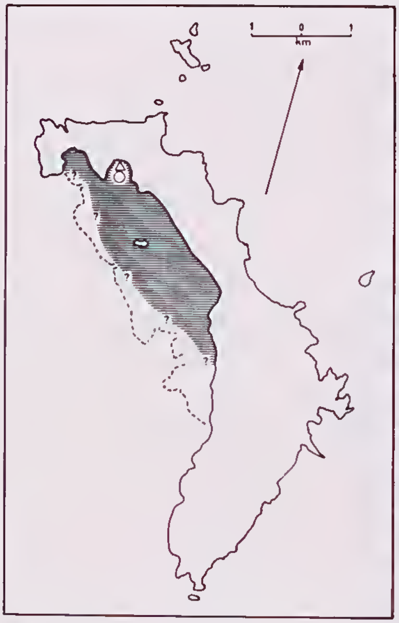
UNESCO equivalent: Rooted underwater community VIID

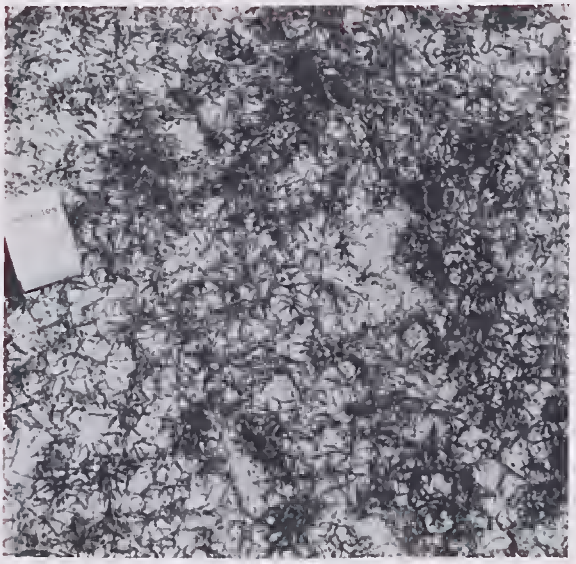
PHYSIOGRAPHY

Generalized site description: Altitude 0 to 3 m; aspect zero; slope low <2°; exposure very low; on floor of lagoon and exposed at low tide.

Geology: Recent lagoon sediments

Soil: Variable, coral sand and mud; coral fragments when present usually <25 mm.





Hunter Bay, off Old Settlement Beach.
Altitude 0 m.

STRUCTURE

Basal area: n.a.

Emergents Nil.

Canopy Height: 0.1 m
Cover: Sparse
Composition: Herbs and algae.

Surface: Uneven
Strata number: 2

Boundaries: Sharp

Ground vegetation (<1 m)
Composition: —

Density: n.a.

Special life-forms: Algae, both as macroscopic "seaweeds" and ± microscopic forms, are abundant.

STRUCTURAL FEATURES OF CANOPY PLANTS — Life-form: Herbs

Crown density: Sparse — Shape: Erect — Branch position: —
Type: — — Stem: Stoloniferous
Bark: — — Roots: —
Leaf size: — — Shape: Narrow — Margin: Entire
Texture: Orthophyll

DISTURBANCE — Agent: Boats

Degree: Low

Location: Various sites over Lagoon.

This disturbance is not very serious and at Lagoon Jetty the stands appear quite vigorous despite heavy boat concentrations and activity.

FLORISTICS (common species only)

Sea grasses
Halophila ovalis
Zostera capricorni

Algae

INCLUSIONS: Nil.

Relationship to other units: Nil.

Boundaries: Sharp.

OTHER DATA

The unit is not mapped but occurs in patches over the entire length of the lagoon.
The stands vary floristically from pure *Zostera* to pure *Halophila* with all possible intergrades. The reasons for this are not obvious.

Sites: Nil.

FORMATION: Open Scrub
Number: 1G1.2b

SUBFORMATION: Open Broad Sclerophyll Scrub
Alliance: AVICENNIA

AVICENNIA MARINA var. *AUSTRALASICA*

Symbol: Ama
Area: 0.6 ha

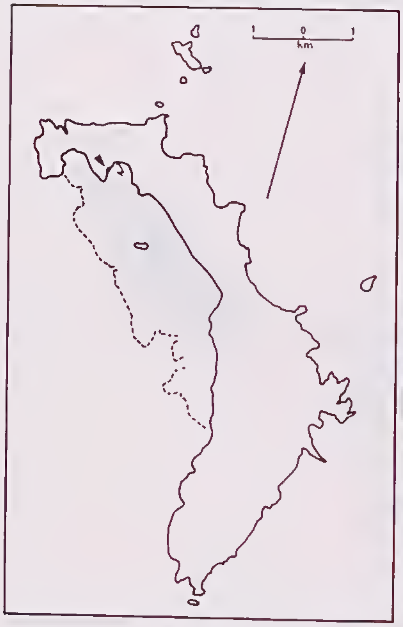
Oliver equivalent: Mangrove *Avicennia officinalis [Avicennia marina* var. *australasica]* Association.

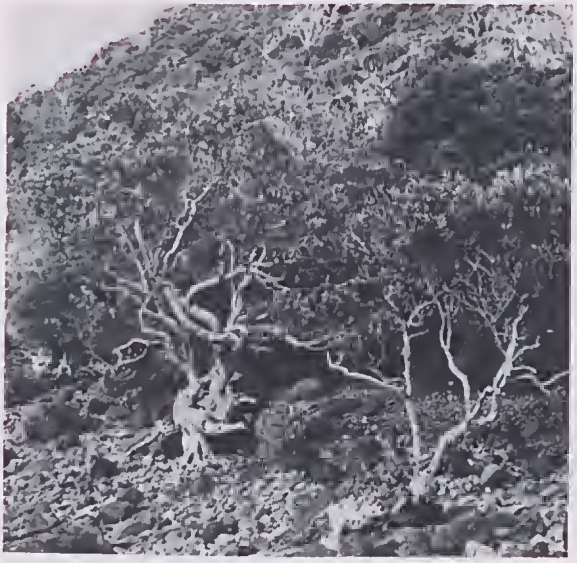
UNESCO equivalent: Evergreen broad-leaved sclerophyllous shrubland IIIA1.d

PHYSIOGRAPHY

Generalized site description: Mud and shingle between high and low tide marks.

Geology: Lagoon deposits between shingles
Soil: Black mud, highly calcareous




West side of Hunter Bay, between Boat Pool and Wedding Lilies. Altitude c.1 m.

STRUCTURE
Basal area: n.d.

Emergents Nil.

Canopy Height: 2.5–4 m
Cover: Sparse, open
Composition: Shrubs.

Surface: Uneven
Strata number: 1
Boundaries: Sharp

Ground vegetation (<1 m)
Composition: —
Density: —

Special life-forms: Possibly some surface algae.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Shrub

Crown density: Sparse
Type: Divergent

Shape: Round
Branch position: Upper half
Stem: Crooked, branchy

Bark: Smooth, fine cracks

Roots: Surface spreading

Leaf size: Notophyll
Texture: Sclerophyll

Shape: Broad
Margin: Entire

Pneumatophores

DISTURBANCE

Agent: —

Degree: Nil.

Location: —

Other: —

FLORISTICS (common species only)

Shrubs
Avicennia marina var. *australasica*

Surface algae

INCLUSIONS: Nil.

Relationship to other units: Nil.

Boundaries: Sharp.

OTHER DATA

The most restricted community on Lord Howe and containing the rarest vascular plants. Only 9 plants were seen: 7 from 2.5 to 4 m high and 2 young plants c.1 m high. The stand is close to the Boat Pool which has a black mud bottom.

Sites: Nil.

MISCELLANEOUS HABITATS Physiographic units which are more convenient mapping units than the heterogeneous vegetation they support.

CLIFFS

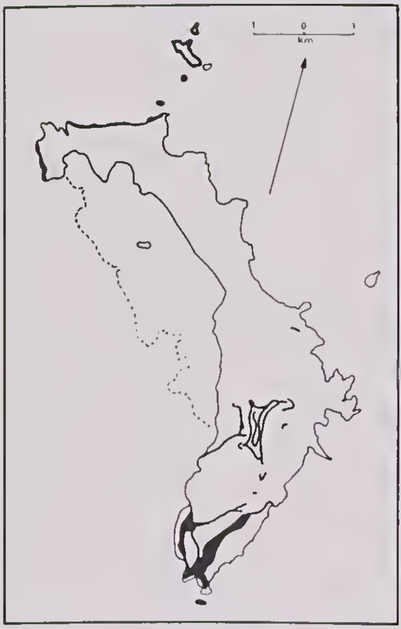
Symbol: Cliff Area: 150 ha, 9.8%

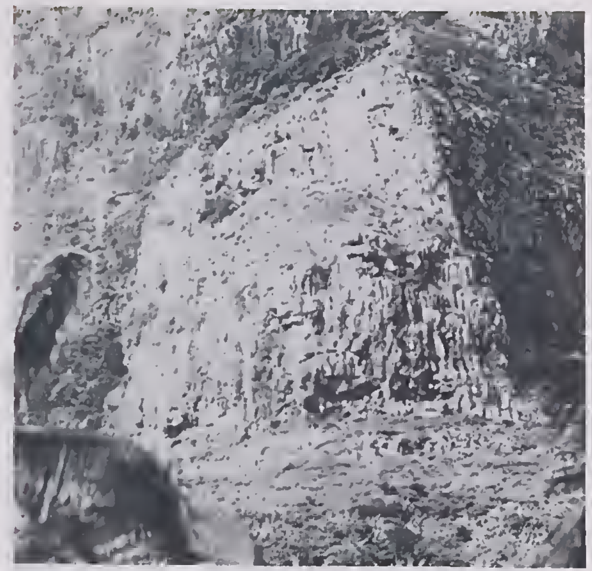
Oliver equivalent: Several—Coastal scrub, hill scrub, rushes etc.

PHYSIOGRAPHY

Generalized site description: Altitude 0–820 m; all aspects; slope >45°, generally >60°; exposure very high; on all positions on slope.

Geology: Basalt, rarely calcarenite Soil: Very variable, but generally shallow and stony





Grey Face, Mount Lidgbird.
Altitude 400 m.

STRUCTURE: Not applicable

STRUCTURAL FEATURES OF CANOPY PLANTS: Not applicable

DISTURBANCE Agent: Goats, birds (see text)

Degree: Locally severe

Location: Northern Hills and southern mountains.

Very local effects of denudation around goat camps. Faecal accumulation probably more important.

FLORISTICS (common species only)

Shrubs
Cassinia tenuifolia
Melaleuca howeana

Herbs
Carpobrotus glaucescens

Grasses
Poa poiformis

The flora on the cliffs is extremely variable depending on location and adjoining vegetation.

INCLUSIONS: Many other units: DaCt, DaCtX, Hc, BhDf, BcMep, Ca, Mh, DfMn, Ax, MFH, Pp.

Relationship to other units: Nil.

Boundaries: Sharp and diffuse.

OTHER DATA

The vegetation on cliffs is so heterogeneous that it is impossible to map at this scale. Generally a cliff face supports low scrub and grass, if dry; but large ledges support vegetation similar, but simpler to that on adjacent slopes.

Site: 21.

Disturbed sites: Nil.

CORAL SAND BEACH AND DUNE

Symbol: Coral

Area: 36 ha, 2.4%

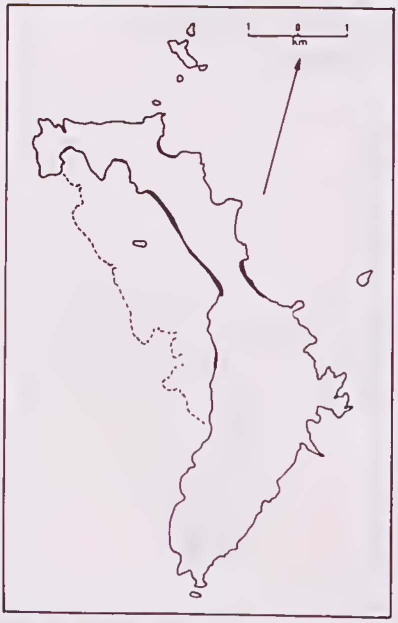
Oliver equivalent: Sand binders *Spinifex hirsutus—Ipomoea pes-caprae [Ipomoea brasiliensis]—Wedelia uniflora [Melanthera biflora]*

PHYSIOGRAPHY

Generalized site description: Altitude 1-5 m; aspect variable; slope low to moderate 1°- 20°; exposure moderate to extreme; lower slopes.

Geology: Recent beach deposits

Soil: Calcareous sands with minimal development.



Lagoon Beach.
Altitude 2 m.

STRUCTURE

Emergents Height: 4 m

Canopy Height: 1 m
Cover: Dense
Composition: Sedges, grasses and herbs.

Ground vegetation (<1 m)
Composition:—

Basal area: n.a.

Distribution: Patches and occasional

Surface: Even
Strata number: 1

Boundaries:—

Density:—

Special life-forms: Creepers and trailers abundant.

STRUCTURAL FEATURES OF CANOPY PLANTS: Mostly not applicable due to mixed nature of communities and lack of dominants.

DISTURBANCE

Agent: Man

Degree: Low to severe

Location: All sites, especially Lagoon Beach.

Disturbance ranges from erection of buildings, garbage dumping and vehicular tracks to occasional fires.

FLORISTICS (common species only)

Small trees
Ochrosia elliptica

Shrubs
Cassinia tenuifolia

Herbs
Cakile edentula
Crinum pedunculatum

Twiners/Lianes
Ipomoea brasiliensis
I. cairica
Melanthera biflora
Muehlenbeckia complexa
Vigna marina

Grasses
Scirpus nodosus
Spinifex hirsutus

INCLUSIONS: Some Calcarenite and Coral Boulder Beach, DaCtX.

Relationship to other units:—

Boundaries: Merges with most adjoining units except Cliff.

OTHER DATA

This unit may be interpreted as a sere in the classical sense but for mapping purposes this is unnecessary. Zonation within the unit is fairly consistent at all sites: *Cakile* and *Spinifex* immediately above high tidemark, then *Scirpus* and creepers, then low scrub and forest.

On the dune near the Ac in Prince William Henry Bay is a stand of *Leucopogon parviflorus*. These are dome-shaped shrubs to 2 m. This stand is interesting as, elsewhere, *Leucopogon* occurs as individuals on basalt.

Sites: Nil.

Photographs: 45, 46.

BASALT BOULDER BEACH

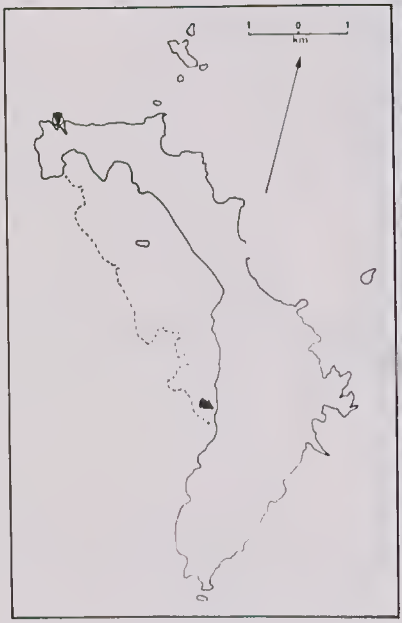
Symbol: — Area: 7 ha, 0.5%

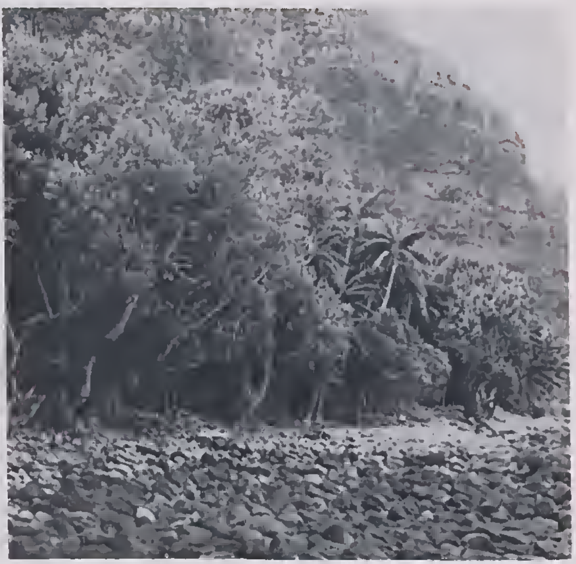
Oliver equivalent: Low succulent plants (halophytes) *Lobelia anceps [Lobelia alata]—Mesembryanthemum aequilaterale [Carpobrotus glaucescens]* Association

PHYSIOGRAPHY

Generalized site description: Altitude 0–2 m; aspect variable; slope low <5°; exposure moderate to extreme; lower slopes.

Geology: Recent deposits Soil: Unknown





N end of Far Flats.
Altitude 1 m.

STRUCTURE

Basal area: n.d.

Emergents Nil.

Canopy Height: 4–10 m
Cover: Dense
Composition: Trees, shrubs and herbs.

Surface: Even
Strata number: 3
Boundaries: Sharp

Ground vegetation (<1 m) Density: Dense
Composition: Herbs, trailing creepers, sedges.

Special life-forms: Succulent herbs rare (usually on calcarenite slabs underlying the basalt boulders).

STRUCTURAL FEATURES OF CANOPY PLANTS: Mostly not applicable due to mixed nature of the communities.

DISTURBANCE: Nil.

FLORISTICS (common species only)

Trees
Drypetes australasica
Howea forsterana
Lagunaria patersonia

Shrubs
Cassinia tenuifolia
Melaleuca howeana

Twiners/lianes
Canavalia rosea
Ipomoea cairica
Melanthera biflora

Grasses & Sedges
Scirpus nodosus
Sporobolus virginicus
Cyperus lucidus

Herbs
Crinum pedunculatum
Lepidium howinsulae

INCLUSIONS: Nil.

Relationship to other units: Closely related to other beach units.

Boundaries: Merges with most adjoining units.

OTHER DATA

Sites: Nil.

CALCARENITE AND CORAL BOULDER BEACH

Symbol: —

Area: 6 ha, 0.5%

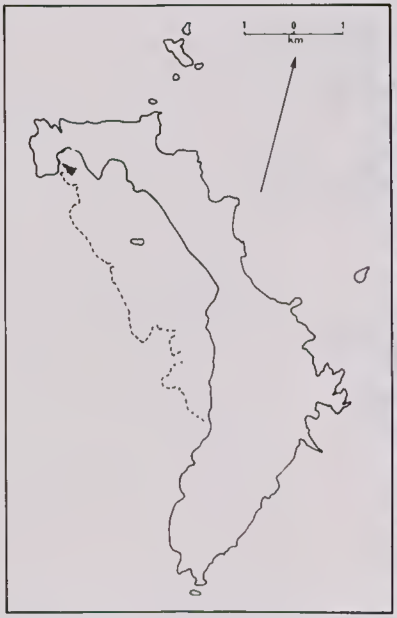
Oliver equivalent: Low succulent plants (halophytes) *Lobelia anceps [Lobelia alata]—Mesembryanthemum aequilaterale [Carpobrotus glaucescens]* Association

PHYSIOGRAPHY

Generalized site description: Altitude 0–1 m; aspect variable but generally W; slope low <5°; exposure high to extreme; lower slopes.

Geology: Recent deposits

Soil: Unknown



SW end of North Beach.
Altitude 1 m.

STRUCTURE

Basal area: n.a.

Emergents Height: 2 m

Distribution: Occasional

Canopy Height: 1 m
Cover: Dense
Composition: Sedges.

Surface: Even
Strata number: 1

Boundaries: —

Ground vegetation (<1 m)
Composition:—

Density:—

Special life-forms: Creepers abundant; succulent herbs occasional.

STRUCTURAL FEATURES OF CANOPY PLANTS

Life-form: Sedge

Crown density: Mid-dense
Shape: Erect
Roots: Rhizome

Leaf size: —
Shape: Terete
Margin: —
Texture: Sclerophyll

DISTURBANCE: Nil.

FLORISTICS (common species only)

Shrubs
Cassinia tenuifolia

Twiners/lianes
Canavalia maritima
Commelina cyanea
Ipomoea cairica
Melanthera biflora
Muehlenbeckia complexa
Vigna marina

Sedges
Scirpus nodosus
Cyperus lucidus

Herbs
Crinum pedunculatum

INCLUSIONS: Nil.

Relationship to other units: Closely related to other beach units.

Boundaries: Merging with most adjoining units.

OTHER DATA

As the unit occurs on actively growing beaches and spits, it may be interpreted as seral. This is not necessary for mapping purposes.
All sites are on actively prograding beaches or spits.

Sites: Nil.

DISTURBED AREAS

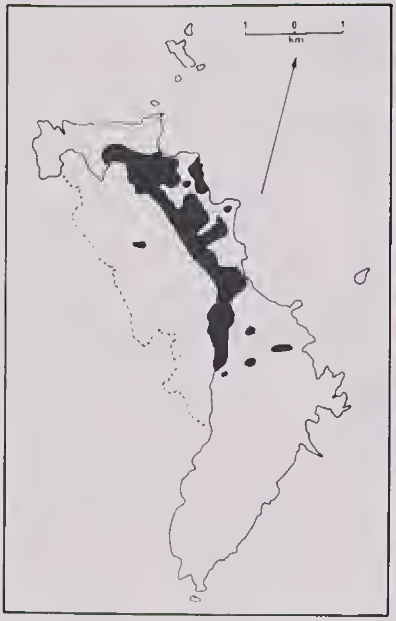
Symbol: —

Area: 248 ha, 16.4%. This % is independent of the others.

Oliver equivalent: Nil.

PHYSIOGRAPHY

Generalized site description: All types of sites regardless of physiography within the following general limits: Altitude 0–80 m; slope 0°– 30°; all aspects; all positions on slopes.



Ray Shicks Bull Paddock, Peach Tree Ridge,
W of Intermediate Hill. Altitude 50 m.

STRUCTURE

Special life-forms: Soft herbs become very abundant; rhizomatous and stoloniferous grasses common.

STRUCTURAL FEATURES OF CANOPY PLANTS: Not applicable.

FLORISTICS (common species only)

Shrubs
**Chrysanthemoides monilifera*
**Psidium cattleianum*
**P. guajava*

Herbs
**Ageratina adenophora*

Grasses
**Chloris gayana*
**Pennisetum clandestinum*
**Stenotaphrum secundatum*

Many other species generally referred to as "weeds". Regrowth of native species, e.g. *Cassinia tenuifolia.*

INCLUSIONS

Relationship to other units: —

Boundaries: Variable

OTHER DATA

Response of vegetation depends to a large extent on the unit and the nature and degree of disturbance.

Sites: 29, 40, 42, 43, 49, 54, 55, 56, 57, 58, 64, 69.

Photographs: 27, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 43, 44, 45, 46, 48.

FACTORS INFLUENCING VEGETATION

Geology

Given the marked physical and chemical differences between soils developed on basalt and calcarenite it is reasonable to expect equally marked differences between vegetation on these substrates. Although I did not specifically sample to examine this question, various data are available for examination. These are structural data from *Howea forsterana* forests and to a lesser extent from *Drypetes-Cryptocarya* forests. Suitable floristic data are available for Lowland Mixed Forest, and for the detailed distribution of individuals of *Howea forsterana* and *H. belmoreana.* Finally, we can compare more general data on growth form, origin and substrate.

Structural data from *Howea forsterana* forests (Table 5) show a consistent pattern: forests on basalt are richer, higher, have larger basal area and are denser than those on calcarenite. No significance tests are made because sample numbers are too small except in the case of height.

Basal area data from *Drypetes-Cryptocarya* forest (Table 5) show the same pattern. However, despite the marked differences in appearance (more-or-less due to structure) between *Drypetes-Cryptocarya* forest and the Calcarenite Facies (DaCtC) there is considerable overlap in the structural data from each community, summarized in the main vegetation table.

For these two examples (*Howea forsterana* and *Drypetes-Cryptocarya* forests) we can show some structural differences, but further detailed sampling would be necessary to suggest that this is a general situation pertaining to all communities.

The first floristic example comes from Lowland Mixed Forest, a community normally found only on basalt. However, one isolated stand occurs on calcarenite between Signal Point and Neds Beach. Several species normally found only on basalt grow here: *Bubbia howeana, Cleistocalyx fullagari, Randia stipulosa* and *Cyperus brevifolius.* This is the only site where these 'basalt species' occur. *Pandanus forsteri* occurs on calcarenite only here and on dry platy outcrops of calcarenite behind Pebbly Beach. *Howea belmoreana* which is rarely found on calcarenite also occurs here (see below). Were it not for the surface outcrops of calcarenite, I would have predicted that the substrate was basalt.

The second floristic example concerns the relative distribution of *Howea forsterana* and *H. belmoreana* on the two substrates. Perhaps the most persistent myth about the vegetation of Lord Howe concerns the distribution of individuals of *Howea forsterana and H. belmoreana.* Etheridge (1889b) reported "a very remarkable fact in connection with the two lowland species [of palms] . . . wherever the soil is derived from the decomposition of the Coral-sand rock [calcarenite], the Thatch Palm (*K. Forsteriana*) [*Howea forsterana*] exclusively prevails, whilst the appearance of the Curly Palm [*H. belmoreana*] at once indicates a volcanic soil". This had not been observed or at least not stated by either Duff (1882) or Moore (1869a) but Maiden (1898) agreed that *"Kentia Belmoreana* [*Howea belmoreana*] will not grow on the coral sandy ground; it is always found on basalt." In 1940 and 1959, Rabone states "*Howea belmoreana,* the Curly Palm, grows on basalt soil only . . ." but his view is almost certainly based on the earlier opinions of Etheridge and Maiden. Oliver (1917) "paid particular attention to the distribution of the two species of *Howea* . . . and considers there is no foundation in fact for the above quoted statements . . ." (i.e., those quoted above here).

Even in 1974 this apparently perfect disjunction was quoted to me by some island residents. I have seen *Howea belmoreana* on calcarenite in only one place: Neds Beach.

TABLE 5

Quantitative data from forests on calcarenite and basalt

Attribute	Calcarenite		Basalt	
A. *Howea forsterana* (Hf) Forest				
Number of species/site	9.9 ± 5.8	n = 7	11.4 ± 6.8	n = 6
Height (m)	7.1 ± 2.7	n = 158	7.9 ± 4.4	n = 104
Basal area (sq m/ha)	703 ± 193	n = 23	793 ± 133	n = 5
Density (stems/ha)	1712 ± 327	n = 9	1884 ± 406	n = 5
B. *Drypetes australasica-Cryptocarya triplinervis* (DaCt) Forest				
Basal area (sq m/ha)	660 ± 241	n = 7	754 ± 155	n = 10

All figures are means ± standard error of mean based on numbers of samples shown (n). Source: Pickard (1978 recalculated, 1980 and unpublished data).

Hf Numbers of species/site: from sites used for computer analysis, altitude range 0–16 m. Height: from transects specifically for sampling palms. Basal area: measured with glass prism. Density: from circular plots of area 84 sq m.

DaCt Basal area: measured with glass prism.

Early photographs clearly show *H. belmoreana* growing on Signal Point on calcarenite but these stands no longer exist. It also grows on alluvium derived from a mixture of basalt and calcarenite at the western foot of Malabar Ridge. Consequently, I agree with Oliver: *Howea forsterana* occurs on both substrates but is much more abundant (by several orders of magnitude) than *H. belmoreana* on calcarenite. Both these floristic examples show how the apparently sharp differences in some communities on the one substrate are obscured when a wider range of variation is examined.

A broader island-scale floristic comparison is possible using field knowledge of the substrates each species occurs on, the origin of each species (native, endemic and naturalized) and the growth-form (tree, small tree, shrub, twiner, herb, graminoid and fern). The resultant 3-way table (Table 6) can be examined to see the effect of substrate. Most of the analysis that follows is restricted to those species growing on only one substrate and not both.

However it is worth asking whether the *total* numbers of species on basalt and calcarenite follow the empirical power law of island biogeography (MacArthur & Wilson, 1967), viz:

$$S = cA^z$$

where
S = number of species
A = area
c = coefficient
z = parameter

For isolated islands z is usually 0.20–0.35, but for areas within an island it is usually 0.12–0.17. Thus for the total numbers of species on basalt and calcarenite we wish to determine z.

Solving $$\frac{S_c}{S_b} = \left(\frac{A_c}{A_b}\right)^z$$ for z,

with $S_b = 325$, $S_c = 268$, $A_b = 1188$ and $A_c = 332$, we find that $z = 0.15$.

Clearly then this is in the range given by MacArthur & Wilson (1967) and we can conclude that the *total* numbers of species on each substrate can be predicted from the theory of island biogeography.

However, the picture is more complex when we examine the numbers of species *restricted* to each substrate. There is no reason to believe that these will follow the same power law, and even less reason to believe that the parameter z will be in the same range as for all species. Thus we cannot use the theory of island biogeography to calculate expected numbers of restricted species for purposes of comparisons.

The best way to examine Table 6 is by considering each of the origins separately and using chi-squared tests of independence to detect interactions. For native species we see that the significant interaction (chi-squared statistic 18.8 with 5 d.f.) is due mainly to herbs which are over-represented on basalt. There are no endemics restricted to calcarenite so there is no interaction in this table. With the naturalized species there is no significant interaction (chi-squared statistic 5.0 with 5 d.f.) between substrate and growth-form. This indicates that the individual growth-forms are mostly represented in the ratio of the marginal total, 18:61.

TABLE 6

Three- and two-way tables of substrate, origin and growth-form; and total numbers of species on the substrates

A. Three-way table

		Growth-form							
Origin	Substrate	Tree	Small tree	Shrub	Twiner	Herb	Graminoid	Fern	Total
Native	Basalt	0	0	5	1	7	19	20	52
	Calcarenite	1	0	1	1	6	2	0	11
	Total	1	0	6	2	13	21	20	63
Endemic	Basalt	5	14	11	1	7	5	16	59
	Calcarenite	0	0	0	0	0	0	0	0
	Total	5	14	11	1	7	5	16	59
Naturalized	Basalt	0	1	0	1	12	4	0	18
	Calcarenite	2	3	8	3	26	19	0	61
	Total	2	4	8	4	38	23	0	79

B. Substrate x origin

Substrate	Native	Endemic	Naturalized	Total
Basalt	52	59	18	129
Calcarenite	11	0	61	72
Total	63	59	79	201

C. Origin x growth-forms

Origin	Tree	Small tree	Shrub	Twiner	Herb	Graminoid	Fern	Total
Native	1	0	6	2	13	21	20	63
Endemic	5	14	11	1	7	5	16	59
Naturalized	2	4	8	4	38	23	0	79
Total	8	18	25	7	58	49	36	201

D. Totals

	Restricted species	Total species	Area (ha)
Basalt	129	325	1188
Calcarenite	72	268	332

Notwithstanding the interaction between substrate and growth-form for native species (mainly due to herbs) that we considered above, there is a highly significant interaction between substrate and origin (Table 7). This is due to over-representation of natives and endemics on basalt and over-representation of naturalized species on calcarenite.

The last major comparison, origin x growth-form, is again highly significant (chi-squared statistic 149.45 with 12 d.f.).

TABLE 7

Summary of chi-squared tests of independence between substrate, origin and growth-form

	Chi-squared	D.F.	Significance
A. Substrate x Growth-form			
Total	34.9	6	**
Native	18.8	5	**
Endemic	—	—	—
Naturalized	5.0	5	ns
B. Substrate x Origin			
Totals	101.05	2	**
C. Origin x Growth-form			
Totals	149.45	12	**

Significance levels: ns p >0.05; ** p <0.01.

Plausible reasons for the significant results can be found in the geological age of the island and the history of settlement. Native and endemic species are over-represented on basalt which is at least 7 million years old. This allows considerable time for speciation and development of particular adaptations to the one substrate. On the other hand, the calcarenite is all late Pleistocene or younger and only a few tens of thousands of years old. This appears to be insufficient time for speciation of "calcarenite endemics".

Since settlement, large areas of lowland have been cleared, the majority on calcarenite. Much of this cleared area is grazed or cultivated, with large numbers of pasture grasses and weeds which are naturalized. The range of habitats is quite different for each substrate and therefore it is impossible to say whether it is the substrate or the habitat that is causing the observed differences.

In summary, these rather broad and crude data highlight many of the readily perceived differences between vegetation on both substrates. All of the comparisons considered above support the view that local differences occur between vegetation on calcarenite and basalt. Some differences operate on a broader scale than others but specific sampling would be necessary before one could confidently state that the differences are due solely to substrate.

Climate

Although the vegetation and the flora are in equilibrium with the present climate, occasional extremes cause severe local damage.

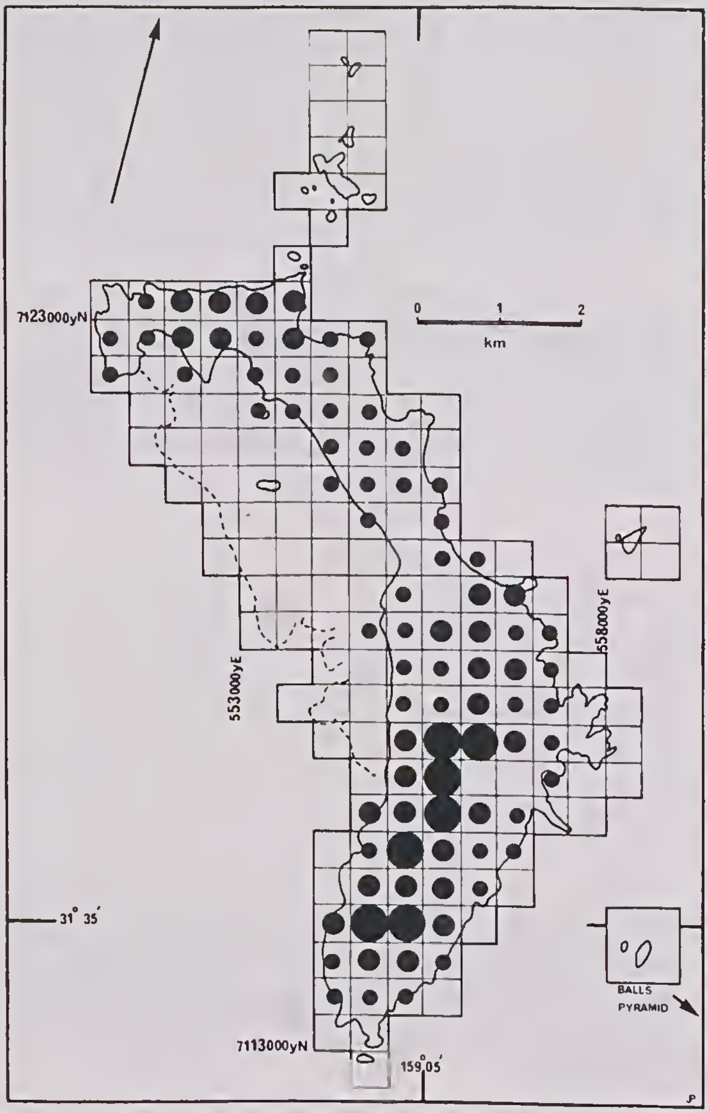


Figure 16. Number of vascular epiphytes recorded in 500 yard (457 m) grid squares. Nineteen species (13 ferns, 6 angiosperms) are regarded as epiphytes although some of the records may refer to occurrences on rocks, logs or soil.

Symbols: blank 0 or no records ● 1-5 species ● 6-10 species ● 10-14 species
Source: Pickard (Unpublished data).

Despite the high rainfall, water is probably a limiting factor in most summers when evaporation exceeds rainfall (Figure 8). This is severely exacerbated on sandy calcarenite soils by extended sequences of rain-free days in summer. In February 1977, after a period of many weeks with virtually no rain, leaves of many trees were showing stress symptoms: dying fronds of *Howea forsterana,* leaf fall on *Drypetes australasica,* and extreme desiccation of herbs in exposed sites. Most of these visible symptoms were reversed after a few light falls of 1–2 mm. However, as flowering in *Howea* *forsterana* takes four years from bud to seed, desiccation stress during a critical physiological phase could affect seed numbers up to four years later.

On an oceanic island it is impossible to separate the effect of wind from the effect of wind-borne salt spray. Exposure to constant wind causes a suite of effects in vegetation: stunted plants; contorted trunks; smooth, dense canopy; reduction in number of "mesic" plants and often, a reduction in leaf size (Boyce, 1954). These effects are well expressed along the coast and on ridges and crests on Lord Howe. For example, on the side of an exposed ridge near Transit Hill in *Drypetes australasica-Cryptocarya triplinervis* forest up to 12 m high, the canopy is smooth with less than 30 cm variation over areas up to one hectare.

The number of vascular epiphytes appears to be partially controlled by microclimate. Nineteen species of vascular epiphytes (13 ferns, 6 angiosperms) occur on the island and the largest numbers of species are found in the southern mountains (Figure 16). However, within this broad pattern, numbers of individuals are equally common in the humid *Bubbia-Dracophyllum* forest and stunted forests on windy exposed sites.

Although the wind resultants (Figure 11) indicate the direction and magnitude of onshore winds, streamlines in the vegetation provide the best integrated indicator of the actual wind direction experienced by the vegetation. The resultants do not correspond closely with canopy streamlines except close to the coast (Figure 11), where the streamlines radiate normally from the shore. Even here the pattern is disturbed by physiographic features acting as funnels or windbreaks, for example, in the bay immediately east of The Saddle, canopy streamlines indicate a northeast effective wind despite the southeast aspect, and at Dinner Run the streamlines show that southerly winds trapped behind Red Point are funnelled north up the creek (Figure 11).

Canopy streamlines in the hinterland are generally normal to ridge crests and fan up out of gullies, but this pattern is modified by topographic obstructions. Thus, immediately south of Mount Lidgbird the streamlines are arcuate, whereas in the bottom of The Saddle about 100 m lower, they are normal to the ridge.

An anomalous situation occurs in Erskine Valley where southeast onshore winds affect leeslope vegetation on a northwest aspect and the relatively weak onshore westerly winds gust violently out to sea to the east. In Erskine Valley on Scaly Bark Ridge (shown by star on Figure 11), the upper limbs of *Cleistocalyx fullagari* trees are bent downhill to the northwest which is in the opposite direction to what would be expected. Southeast winds flow up over The Saddle and down the ridges in Erskine Valley and the wind-sensitive *Cleistocalyx* trees assume the anomalous downhill bending. Fitzgerald (in Hill, 1870) provides an entertaining description of a storm in Erskine Valley: "The water on the saddle [sic] on which Ned [Edward King] counted has been destroyed by pigs, so they descend a little into Erskine Valley . . . in search of water . . . The wind began to whistle up the valley, then came a peal of thunder and the large drops pattered. Then peal on peal, and flash on flash, and the wind grew into a furious gale that cut through to the very marrow in the bones . . . at the narrow end of a tunnel through which wind and rain rushed furiously . . . ."

This rather coloured description of a storm provides testimony of the lee slope winds. Evidence of the concentration of the weak westerlies is provided by an inscription southeast from The Saddle on the nautical chart of the island*, which warns: "Ships approaching this 'Mountain aspect' nearer than 1½ miles will risk (with off-shore winds) dismasting by the gusts which alternate with dead lulls". While

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*The original chart was drawn in 1853 by Captain H.M. Denham R.N. and published in 1863 as "South west Pacific, Lord Howe Island and Ball's Pyramid-Lord Howe Island and adjacent islets and reefs" by the Admiralty. Current editions still bear the caution.

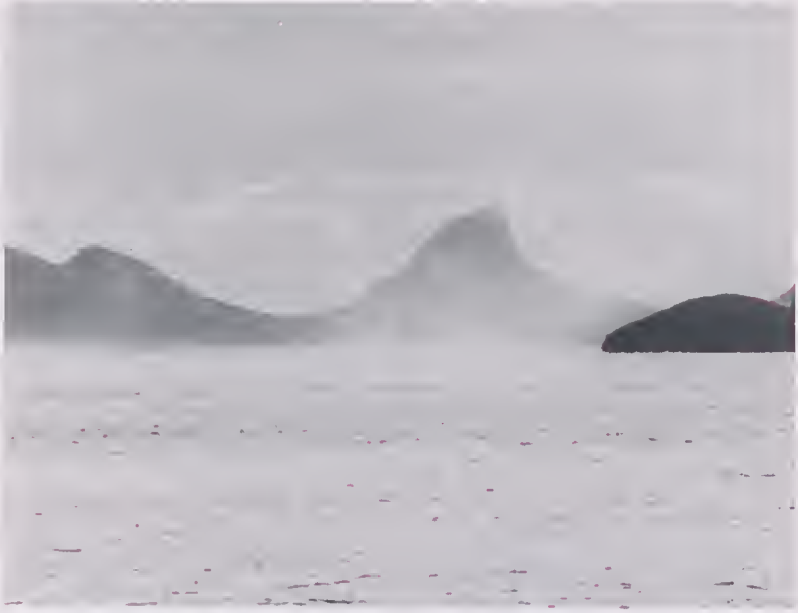

Figure 17. Salt spray blowing off the coral reef during a strong southwesterly wind. Mount Eliza in the rear, Rabbit Island on the right.

there is other evidence that Fitzgerald tended to exaggerate, the quality of the chart prepared by Denham gives little indication that he was anything but a meticulous and accurate cartographer. His inscription shows that winds gust up Erskine Valley, over The Saddle and out to sea with unfortunate consequences to unwary mariners.

Strong winds and cyclones are not unknown on Lord Howe (p.148) but are of such short duration that they have little effect on, for example, streamlines. Severe damage to vegetation during cyclones is rare and, even then, very localized. At the most, some trees are blown over or fall over when the rain-soaked soil slumps.

Salt spray carried by the wind reaches virtually all parts of the island. As early as 1853 Macdonald observed that wind "often proves destructive to vegetation, by blowing the finely-divided spray from the reef over the unprotected parts. From May to September it is most severe, and its blighting influence is frequently observed within a few hours, bananas, potatoes, and many other plants become quite black and shrivelled up." Oliver (1917) in describing the valley between Old Gulch and Mount Eliza says that "on windy days the whole valley is drenched with salt spray." Salt drops are carried to at least 70 m elevation on Dawson Point Ridge during moderate storms (Figure 17, field observation 13.v.1971). It is difficult to estimate how high salt is blown but indirect evidence suggests that it reaches the top of the mountains. Several species of sea-birds (Masked Booby, *Sula dactylatra;* Red-tailed Tropic Bird, *Phaethon rubricauda;* and Providence Petrel, *Pterodroma solandri*) soar from sea-level to heights in excess of 1000 m on updraughts up the faces of cliffs. Foliar analyses for sodium of *Randia stipulosa, Bubbia howeana* and *Pittosporum erioloma* from 25, 200 and 840 m show no decline with altitude (Pickard, 1978).

The rate of deposition depends largely on wind and sea swells, and after storms even plants believed to be salt tolerant may show leaf death, for example, foredune colonizers such as *Vigna marina, Ipomoea brasiliensis* and the naturalized *Hydrocotyle bonariensis.* Some trees, for example, *Howea forsterana* and *Lagunaria patersonia* also have salt-scorched leaves after gales. Salt spray is a major factor in the formation of "secondary canopies" discussed below (p.249).

Along most of the coast of Lord Howe there is little evidence of the "salt spray community" of Boyce (1954), except within a few metres of high-tide mark. Immediately behind this strip the dominant forests start. *Howea forsterana* forest provides a good example: it grows from sea-level to at least 360 m on a variety of substrates. At Little Island and Far Flats (pp.000, respectively) the forest is immediately above a narrow band of sedges and twiners. The presence of storm-washed flotsam inside the edge of forest at Far Flats shows how exposed the community is here. Both these stands are about 5–10 m high, but a much lower stand occurs in the lee of the sand dune at Blinky Beach (Figure 44). The palms here showed extensive leaf death after a storm in 1972.

The *Drypetes australasica-Cryptocarya triplinervis* association behaves in a similar manner, except that near the more exposed sections of the coast it is replaced by the exposed facies of the association. The two Narrow Sclerophyll Scrub communities are probably the nearest thing to a 'salt spray community' on the island. Both *Melaleuca howeana* and *Cassinia tenuifolia* associations are virtually restricted to exposed cliffed headlands along the coast (see vegetation map). These stands show most of the features described earlier.

The Gnarled Mossy Forest on Mounts Lidgbird and Gower is evidence of the very regular and persistent cloud on the mountains. Inside the cloud, evaporation and transpiration are reduced and humidity is increased. Effective precipitation inside the cloud is higher than outside and much of this increase comes from direct interception of cloud water by vegetation. However, this microclimate is subject to rapid change. Within the space of 30 minutes in February 1976 conditions on Mount Gower changed from dripping cloud to sunny and dry. At the same time, epiphytic filmy ferns and macrolichens changed from soggy to dry and brittle.

The razorback summit of Mount Lidgbird has less cloud than the summit plateau of Mount Gower and the vegetation reflects this. There are fewer species and individuals of non-vascular epiphytes, and the *Bubbia-Dracophyllum* Gnarled Mossy Forest is less well developed.

Sea-birds

Subfossil bones of sea-birds indicate that large numbers of birds have nested on the island for a long time (van Tets & Fullagar, 1974). Short-term and local effects are visible. The estimated one million pairs of nesting birds (Table 8) influence the development of vegetation on two levels: at the individual plant level and at the community level. I will consider four bird species which affect individual plants, then birds which affect weed distribution and finally the role of another species in the forests.

Noddies (*Anous stolidus*) roost, among other places, in shrubs of *Melaleuca howeana, Lagunaria patersonia* and *Celtis amblyphylla* (Figures 18 and 19). This kills or causes a general die-back in *Melaleuca,* but the broad-leaved *Lagunaria* and *Celtis* appear unaffected. Masked Boobies (*Sula dactylatra*) nest on the ground between tussocks of *Poa poiformis* and *Cyperus lucidus* (Figure 20) and kill one or two adjoining tussocks by mechanical damage and/or excess faecal nutrients. Wedge-tailed Shearwaters (*Puffinus pacificus*) nest in shallow burrows wherever there is sufficient soil on the off-shore islets. More often, because the soil is too shallow, the nest is merely a cave excavated under a tussock of *Poa poiformis* or *Cyperus lucidus* (Figures 20 and 21). Death of these tussocks is frequent in dry summers when the little soil present dries out. On the summits of Mounts Lidgbird and Gower, there are sometimes dead mosses and lichens around the entrances to the burrows of Providence Petrels (*Pterodroma solandri*). During nesting, the petrels contribute to mass-movement of the usually wet soil but there is no indication that the vegetation is not able to tolerate the movement. Many stems are curved at the base apparently compensating for

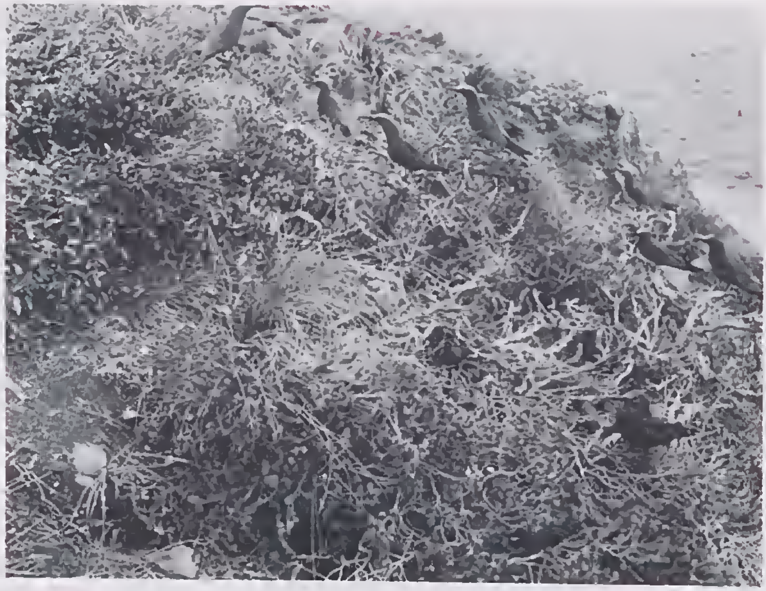

Figure 18. Large amount of twig death on *Melaleuca howeana* caused by nesting noddies (*Anous stolidus*) on Roach Island. Compare with *Lagunaria* in Figure 19. Burrow of Wedge-tailed Shearwater (*Puffinus pacificus*) in left foreground partially obscured by herbs.

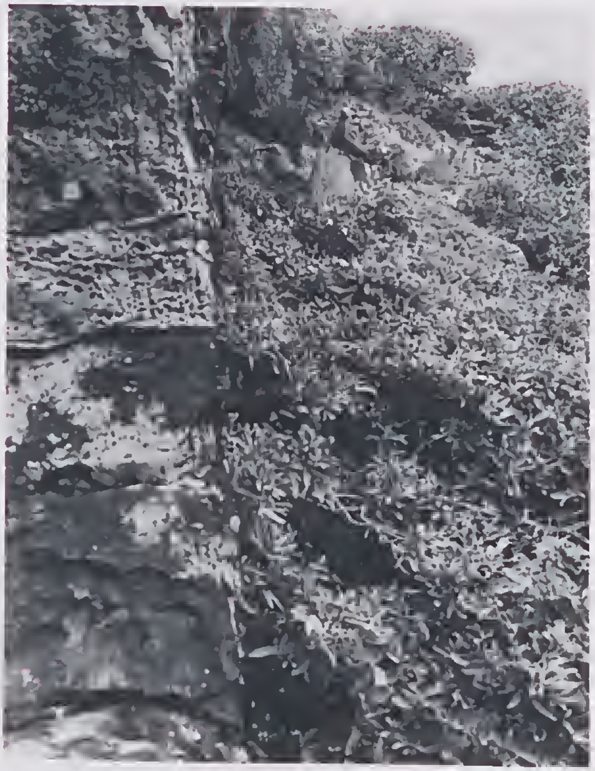

Figure 19. Noddies (*Anous stolidus*) nesting on *Lagunaria patersonia* sheltered by a basalt dyke on Roach Island cause virtually no twig death. Compare with *Melaleuca* in Figure 18.

TABLE 8

Summary of numbers and distribution of seabirds†

Species	Number of breeding pairs	Breeding season	Main distribution	Nest	Vegetation*
Sooty Tern *Sterna fuscata*	100 000–1 000 000	Sept-Jan	Offshore islands, Malabar cliffs	Surface	IcCg, Cl, Pp, Cliff
Wedge-tailed Shearwater *Puffinus pacificus*	28 500	Nov-Mar	Offshore islands, Phillip Bluff-Phillip Point	Short burrows	IcCg, Cl, Pp, Cliff
Providence Petrel** *Pterodroma solandri*	>20 000	May-Oct	Mts Lidgbird and Gower alt. >535 m.	Long burrow	Cg, Hc, BhDf, BcMep
Fleshy-footed Shearwater** *Puffinus carneipes*	17 500	Nov-Mar	Calcarenite area Neds Beach-Valley of Shadows	Long burrow	DaCt, Hf
Masked Booby *Sula dactylatra*	300	Sept-Apr	Roach & Mutton Bird Islands, Mutton Bird Point	Surface	IcCg, Cl, Pp

† Source: Fullagar *et al.* (1974), and field observations.
* Vegetation abbreviation: See Table 4.
** These estimates have been confirmed by detailed counts (P. Fullagar, pers. comm. 1981).

downslope creep of the soil. In each of the above examples the effects are localized and restricted to individual plants.

One consequence of both the high nutrient levels and mechanical disturbance in the nesting areas is the enhancement of the weed distribution. For example, there are many exotic weeds in openings in the *Boehmeria-Macropiper* scrub and *Hedyscepe* palm forest on the terrace, and *Bubbia-Dracophyllum* forest on the summit of Mount

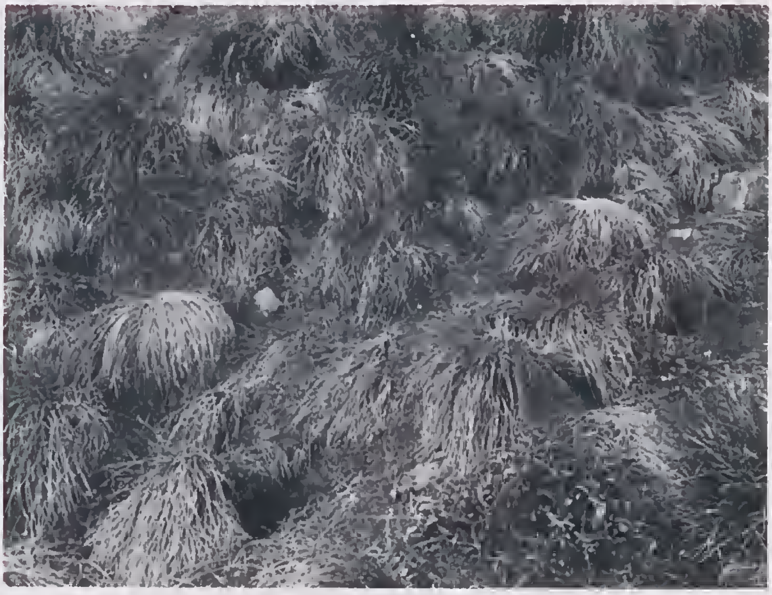

Figure 20. Burrows of Wedge-tailed Shearwaters (*Puffinus pacificus*) under tussocks of *Poa poiformis* on Roach Island.

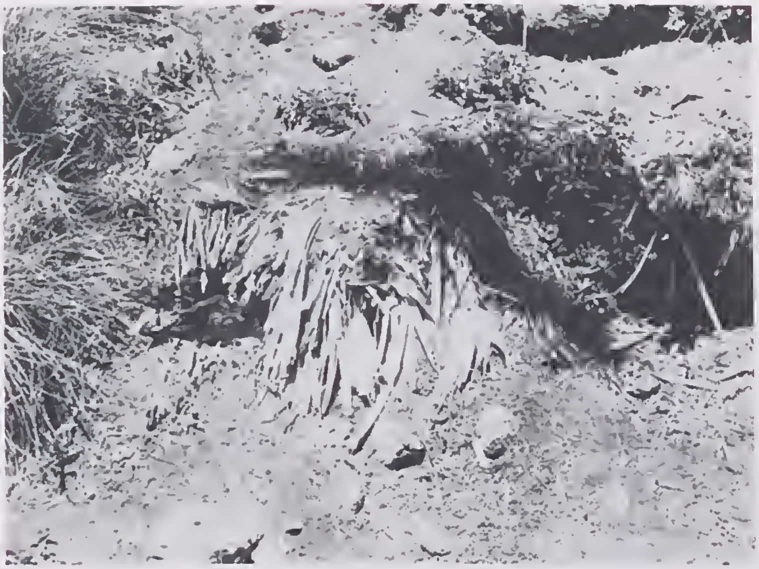

Figure 21. Tussock of *Cyperus lucidus* killed by burrowing Wedge-tailed Shearwaters (*Puffinus pacificus*) on Mutton Bird Island.

Lidgbird. These areas are inaccessible to feral animals and have few human visitors, so the only likely dispersal mechanisms are wind and/or birds. In either event, adventive species such as *Bidens pilosa, Bromus unioloides, Cerastium glomeratum, Gnaphalium spicatum, Hypochaeris radicata, Lilium formosanum, Poa annua, Rumex brownii, Solanum nodifolium, Sonchus oleraceus* and *Verbena bonariensis* are scattered over the nesting areas.

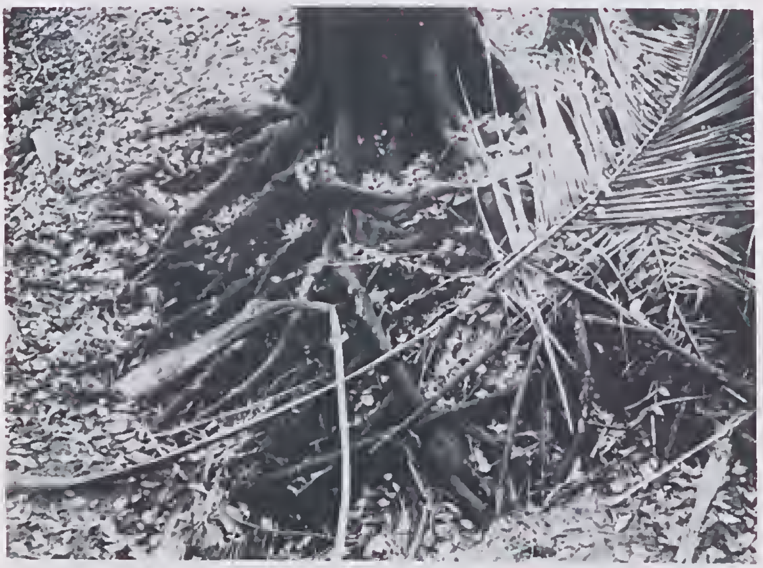

Figure 22. Network of surface roots of *Drypetes australasica* exposed after collapse of burrows of Fleshy-footed Shearwaters (*Puffinus carneipes*) in *Howea forsterana* forest. On the Big Mutton Bird Ground above Stevens Point.

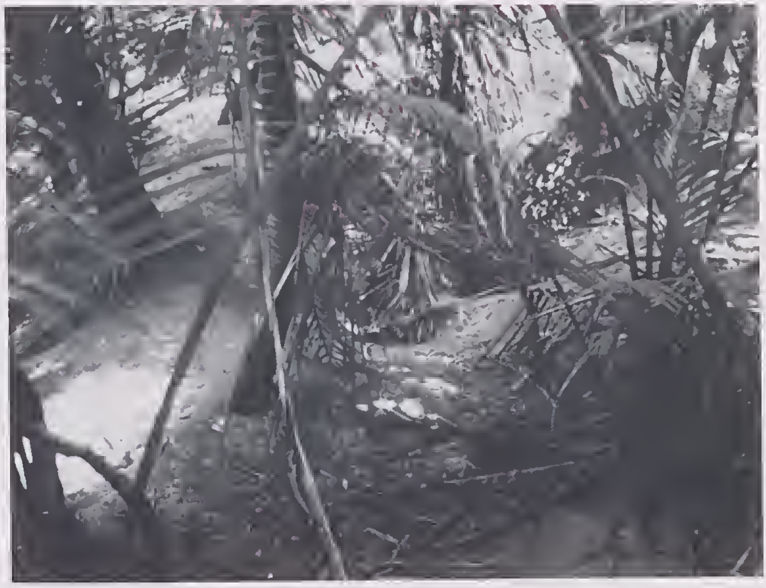

Figure 23. Young plants of *Howea forsterana* in a *H. forsterana* forest with many burrows of Fleshy-footed Shearwaters (*Puffinus carneipes*). No seedlings are visible. On the Big Mutton Bird Ground above Stevens Point.

On the off-shore islands, which are also inaccessible and infrequently visited, a more restricted but similar weed flora is developed on nesting areas: *Anagallis arvensis, Chenopodium murale, Oxalis corniculata, Polycarpon tetraphyllum, Solanum nodifolium, Sonchus oleraceus* and *Digitaria sanguinalis.*

Fleshy-footed Shearwaters (*Puffinus carneipes*) nest in *Howea forsterana* and *Drypetes-Cryptocarya* forests on calcarenite in the Big Mutton Bird Ground which runs from Neds Beach to Valley of the Shadows. The shearwaters nest in burrows up to 1.5 m long and 1 m deep in the sandy soil below a network of shallow roots which reinforce the burrow roofs. When burrows are disused between breeding seasons or when the soil dries out in droughts, the roofs often collapse leaving trenches crossed by a network of exposed roots (Figure 22). Conversely, the roots of some trees are covered with soil excavated from burrows. Some island residents assert that these conditions kill canopy plants and prevent regeneration in both *Howea forsterana* and *Drypetes-Cryptocarya* forests. The area is an ideal site to examine the vegetation/bird equilibrium and seek evidence of bird damage to the forests.

In the *Drypetes-Cryptocarya* forest between Neds Beach and Jims Point there are virtually no seedlings of the two dominants and there is no other understorey present. Further south above Middle Beach there is a sparse understorey of young canopy plants. Canopy cover in these forests (80–100%) is similar to other *Drypetes-Cryptocarya* stands with more abundant seedlings and denser understoreys but no nesting birds. *Howea forsterana* forest here is uneven-aged with many seedlings and young plants (Figure 23) but these are fewer than occur in other stands without birds.

These observations partially support the assertion that the birds damage the forests. However, I believe a more realistic view is to consider that the nesting birds reduce the density of young plants but not to levels that prevent maintenance of the present communities.

Introduced animals

Five of the exotic animals now on Lord Howe affect the vegetation (Table 9). Four, goats, pigs, rats and man, are notorious for their ability to alter and damage vegetation on oceanic islands. Cattle do not enjoy the same unenviable reputation, but on Lord Howe cattle are second only to man for the damage they cause. As the effects of cattle are a consequence of management decisions by man, I will discuss both in the next section.

The following discussion of goats is a brief summary of earlier studies (Pickard, 1976). Goats were introduced as domestic livestock before 1850 and were running wild by 1851. Until the extermination programme started in 1970-1971, goats roamed the northern hills and southern mountains (Figure 42) but preferred the low forest and scrub of exposed sites (Figure 24). Generally, the only evidence of goats was the existence of small bare patches near their camps and a typical flora of nitrophilous weeds. By 1981, the goat population had been reduced (especially in the northern hills) but not eliminated.

TABLE 9

Exotic mammals which affect the vegetation†

Species	Distribution	Vegetation*	Activity
Goat *Capra hircus*	Northern hills, southern mountains, Little Slope (now eliminated), Rabbit Island. (Never on summit of Mount Lidgbird, or other offshore islands).	Cliffs, exposed areas. DaCt, DaCtx, Hf, BhDf, Ca, Mh, DfMn, MFH, Pp.	Browsing, camping in caves, faecal downwash from camps.
Pig *Sus scrofa*	South of Intermediate Hill, particularly Fern Patches and Erskine Valley; Big Slope (Never on offshore islands).	Forested areas. DaCt, Cf, Cq, LM, Cg, Hb, Pf, BhDf(?), DfMn.	Rooting for rhizomes eating seeds.
Rat *Rattus rattus*	Entire island (Never on offshore islands).	All types, especially BhDf, Hc, Hf.	Eating seeds, fruit, rhachis.
Ox *Bos taurus*	Cleared lowlands and adjacent areas.	Cleared and disturbed forest.	Browsing, grazing, spread of weeds, prevention of regeneration.
Man *Homo sapiens*	Northern hills, cleared lowlands and adjacent areas, tracks through bush. Rarely in areas with difficult access.	All types where readily accessible.	General destruction for building, grazing, etc., accidental spreading of weeds, trampling.

* Vegetation abbreviations: See Table 4.

† Source: Pickard (1976, unpublished data and field observations).

As early as 1869 goats were blamed for damaging the vegetation but little evidence was available. By comparing Oliver's (1917) description of Little Slope with the present vegetation, I have shown how goats destroyed a large stand of *Cyperus lucidus* Tall Grass and removed all small plants of *Howea forsterana* (Pickard 1976, unpublished data). Using Oliver's description of vegetation between North Beach and New Gulch, it is possible to refute an assertion by several island residents that the *absence* of goats following the extermination programme has caused changes. The residents assert that the goats maintained the vegetation in an essentially grass- and sedge-free state, and that when goats were eliminated the vegetation was invaded by *Phragmites australis, Poa poiformis* and *Cyperus lucidus* to form the present cover.

Oliver describes the vegetation between North Beach and New Gulch as: ". . . an open-scrub association mixes with the herbaceous plant formations. In the most

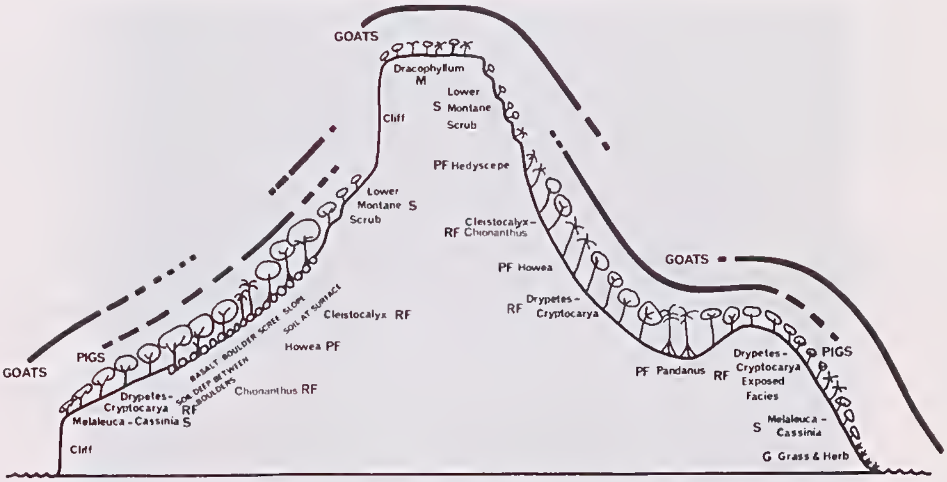

Figure 24. Diagrammatic cross-section of the southern mountains showing habitat preferences of goats and pigs. Goats prefer low forest and scrub on exposed sites, pigs the denser and taller forests on sheltered sites. Goats also browse on the summit of Mount Gower in the dense *Bubbia-Dracophyllum* forest (from Pickard 1976).

Abbreviations: RF Rain forest

PF Megaphyllous broad sclerophyll forest (palm and pandan)

M Montane forest and scrub

S Scrub

G Short grass and broad-leaved herb vegetation

exposed portions there occur large rounded bushes of *Melaleuca ericifolia* [*M. howeana*], 6 m. to 8 m. across and ½ m. to 1½ m. high, closely fitting the ground all round, and highest in the centre [Figure 25]. Other shrubs scattered here and there in the meadow formation are *Cassinia tenuifolia, Myoporum insulare* and *Coprosma prisca*.

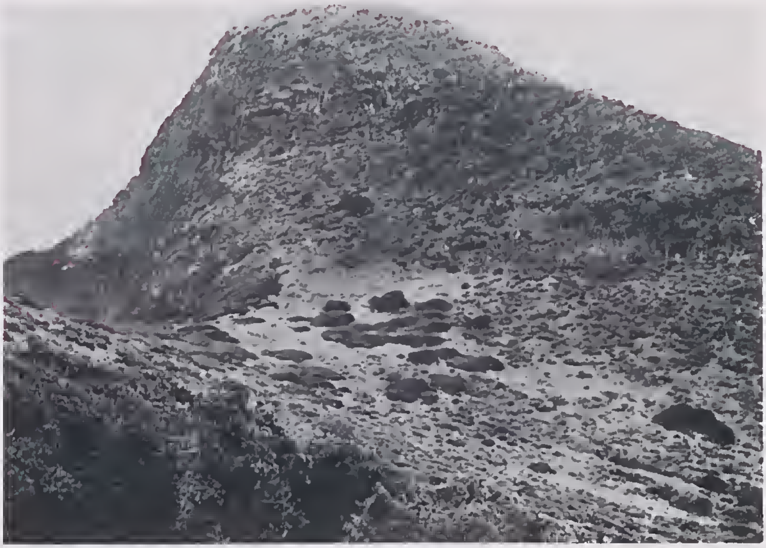

Figure 25. Mount Eliza and the gap above New Gulch from the west. Domes of *Melaleuca howeana* occupy the lowest section of the gap. Further right (towards North Beach and Figure 26) are sparse shrubs of *Cassinia tenuifolia*, mixed with *Poa poiformis, Cyperus lucidus, Phragmites australis* and *Scirpus nodosus*. The mid slopes of Mount Eliza support *Drypetes australasica-Cryptocarya triplinervis* exposed facies which merges into the low scrub and grass on the upper slopes.

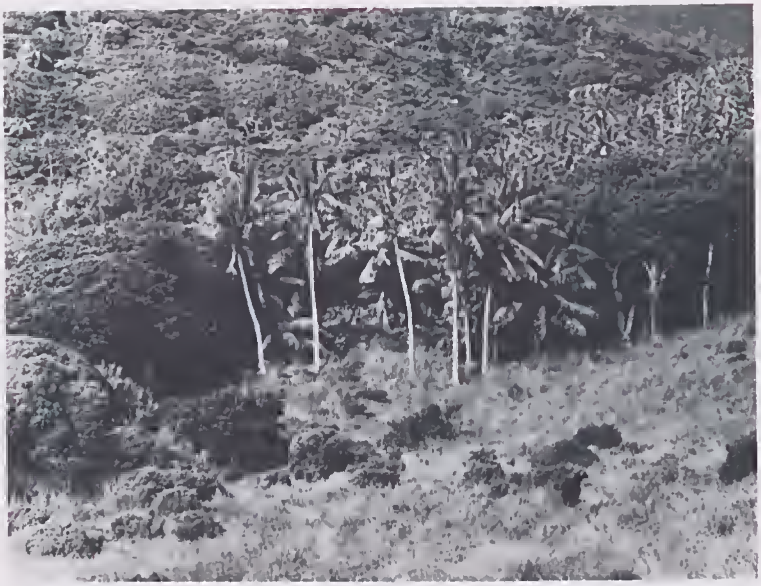

Figure 26. A small black goat (lower right foreground) in *Poa poiformis* and *Scirpus nodosus* Short Grass north of *Howea forsterana* forest between North Beach and New Gulch. Scattered shrubs of *Cassinia tenuifolia* and *Myoporum insulare* occur left of the goat. Oliver's (1917) description of this area reveals that the vegetation has not changed since 1913.

"In the gap between Mount Eliza and North Head the wind continually sweeps through, usually with great violence. Here there are no trees and only a few detached shrubs, but the area is occupied by formations of herbaceous plants. In the most exposed portion are low succulent plants . . . *Mesembryanthemum aequilaterale* [Carpobrotus glaucescens] and *Lobelia anceps* . . .". This ". . . is replaced on the leeward side by a covering, 1 m or more tall, of rushes and grasses, with a few shrubs intermixed . . . *Scirpus nodosus* is the dominant plant. Each side up the hillslope it mixes with *Cassinia* scrub, which then passes to forest. Among the *Scirpus* there grow *Poa caespitosa* [*P. poiformis*], *Cynodon dactylon, Lobelia anceps* and the trailing plant *Ipomoea palmata* [*I. cairica*].

"Over extensive areas the tall grass *Phragmites communis* [*P. australis*] is mixed with *Scirpus nodosus* and the shrub *Cassinia tenuifolia.* The whole association is very dense and up to 2 m. in height. Trailing over it are *Ipomoea palmata* [*I. cairica*] and *Stephania Forsteri* [*S. japonica*]. In the lowest portion of this formation near the forest large shrubs, 3 m. tall of *Coprosma prisca* and *Myoporum insulare* are fairly common."

This description applies perfectly to the vegetation in the area in 1970 when goats still grazed and browsed (Figure 26). I have been unable to detect any appreciable change since the virtual elimination of goats, but I lack quantitative data. There is no evidence to support the islanders' claim.

Although many visitors have commented in passing on the effects of pigs, no detailed studies have been made. The following discussion is summarized from Pickard (1978). Pigs were present on the island in 1839 as domestic stock, and were feral by 1851. They are still present but are restricted to the southern mountains south of Intermediate Hill (Figure 42). They have preferred habitats, dense forest, which overlap slightly with those of goats (Figure 24). Despite a concerted extermination programme from 1977 to 1981 a few pigs still remained in 1981.

By 1869 the vegetation was apparently showing the effects of 20 years grazing by pigs and goats. However, it is impossible to separate pig and goat effects except in certain areas, for example, Little Slope, where there have been no pigs for 50 years. The main effects of pigs seem to be rooting-up areas in search of roots and rhizomes. This leaves a churned-up soil surface, which together with nutrients from faeces makes an ideal seed-bed for weeds. As most pig activity is restricted to dense forests where light levels are low, weed invasion is low. By 1981, following virtual elimination of the pigs, there was much less direct evidence of rooted-up areas.

Rats are the most recent invader of the island; they did not arrive until 1918, 76 years after settlement. Today, only the off-shore islets are rat-free (Figure 42). Rats cause considerable loss of palm seed which seriously reduces income to the island. Despite this, no studies have been made. Their main effect is seed predation on a range of plants, for example, *Howea* spp., *Hedyscepe, Lepidorrhachis* and *Chionanthus.* They also eat flowers of *Dietes,* and the rhachis of *Hedyscepe* and *Cyathea howeana.* On Little Slope a large rat population, combined with goats, has prevented regeneration of *Howea* forest for almost 50 years.

Although the Lord Howe Island Board has poisoned rats for many years, the effect is negligible away from the settled areas. Until 1980 the programme was a failure because it was not based on information on distribution, behaviour or feeding preferences of the rats. In 1980 a new blanket-poisoning programme commenced in many areas. This has reduced rat numbers considerably.

The effects of all the feral mammals are poorly known and understood. Since 1977 data on pig stomach contents, rat density and habitat preference have been accumulated (B. Miller, pers. comm.) but have not been analysed. This information should define the nature of the problem caused by the feral animals and suggest worthwhile avenues and methods of control and extermination.

Settlement

Lord Howe Island was free of *Homo sapiens* until it was sighted in 1788 and subsequently settled in 1833. The early settlers cleared vegetation to survive: they needed gardens and pastures. Once the settlement was established, the needs changed: to vegetable export in the 1850's, to palm seeding in the 1890's and to tourism in the 1930's. Each phase continued the disturbance and expanded the cleared area.

In gross terms the 150-odd years of settlement have had little effect on the vegetation: less than 20 per cent of the vegetation is disturbed and less than 10 per cent is cleared. However, these gross percentages conceal severe local damage, and both past and continuing disturbance for both economic and other motives. I will discuss effects of clearing for gardens and pastures, palm seeding, construction, and finally some consequences of tourism and attempts at aesthetic improvement.

Old Field Succession

In the past, many islanders practised shifting cultivation. An islander chose a piece of forest, cleared it, planted vegetables or fruit trees and cultivated it for a few years before abandoning it. Frequently another islander would take over the management, often with a different crop. After abandoning it, the islander may seek out another new site and repeat the process. Consequently the central section of the island is dotted with small abandoned gardens, which are sites of old field succession and foci for weed invasion.

Abandoned gardens were first described by Moore (1869) "[Abandoned gardens and] clearances of the flats are now almost wholly occupied by two grasses which are common about Sydney, *Cynodon dactylon* and *Sporobolus elongatus*

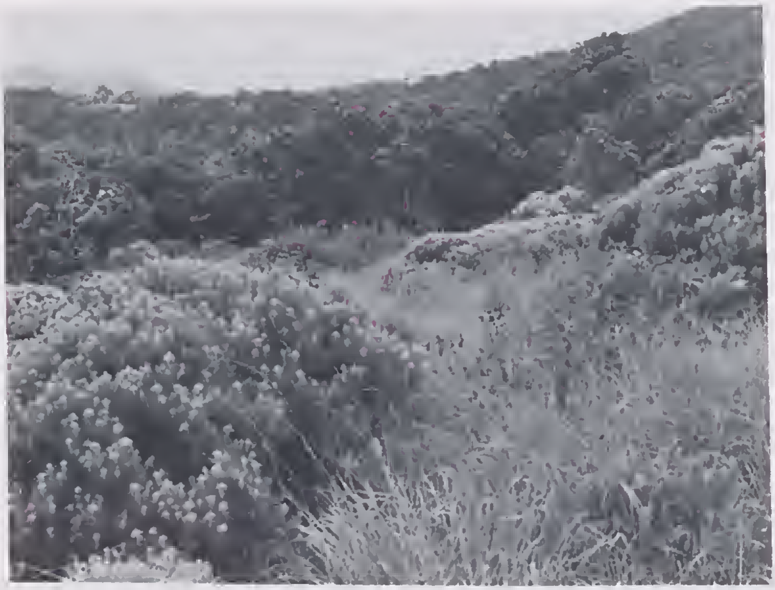

Figure 27. Dome-shaped shrubs of *Cassinia tenuifolia* and *Ageratina adenophora* (erect herb between *Cassinia*) invading pasture of native grasses and sedges in Portion 130 (see Figure 28).

[S. africanus]".". . . *Verbena bonariensis, Ricinus communis, Solanum lacinatum* [*S. aviculare*], *Sonchus oleraceus,* and other smaller kinds, evidently foreigners to the soil, had, from neglect, taken almost entire possession of fine tracts of cleared ground, and had become in other parts very troublesome weeds." *Solanum aviculare,* which I consider native rather than introduced, is now rare on abandoned clearings at low altitudes. *Ricinus communis* has a chequered history (Pickard, unpublished data) on the island; sometimes abundant, sometimes rare. From 1970 to 1981 it was uncommon on old clearings. It is virtually impossible to document the chronology of owners, management, and crops of the various gardens. I will discuss several examples for which I have good information, as they illustrate the general principles. The discussion is based largely on old maps (particularly Ferrier's 1923 map; Pickard, unpublished data), field observations and discussions with elderly residents of the island.

The consequences of clearing are best considered on a scale of increasing complexity, outlined here and discussed in detail over the next few pages. The simplest clearing is a small opening in the forest which is immediately abandoned (e.g. portion 54). Next is an abandoned pasture being invaded by native species (e.g. portion 130) or exotic shrubs (e.g. Retmocks Garden, Valley Garden). More complex again is the onset of a steady state when neither pasture nor forest advance (e.g. Fred Nichols Garden). Next is the steady state relying on the presence of grazing cattle and fences (e.g. Stevens Point). Finally there is the interaction of clearing, grazing and wind (e.g. above Middle Beach). All these examples and some others are considered in more detail below.

Portion 54 is a tongue of *Drypetes-Cryptocarya* forest on basalt protruding into the *Howea forsterana* forest behind Neds Beach. In 1923 Ferrier described this area as "overgrown and dense palm". At some time in the 1950's it was cleared by a resident for a house which was never built and the clearing was abandoned. The clearing is now well covered by dense regrowth of the various trees from the surrounding forest: *Cryptocarya, Drypetes, Celtis.* The soil surface is covered with a mat of *Vinca major,* an introduced herb, which is restricted to this immediate vicinity. A similar example occurred along an electricity power line which until 1980

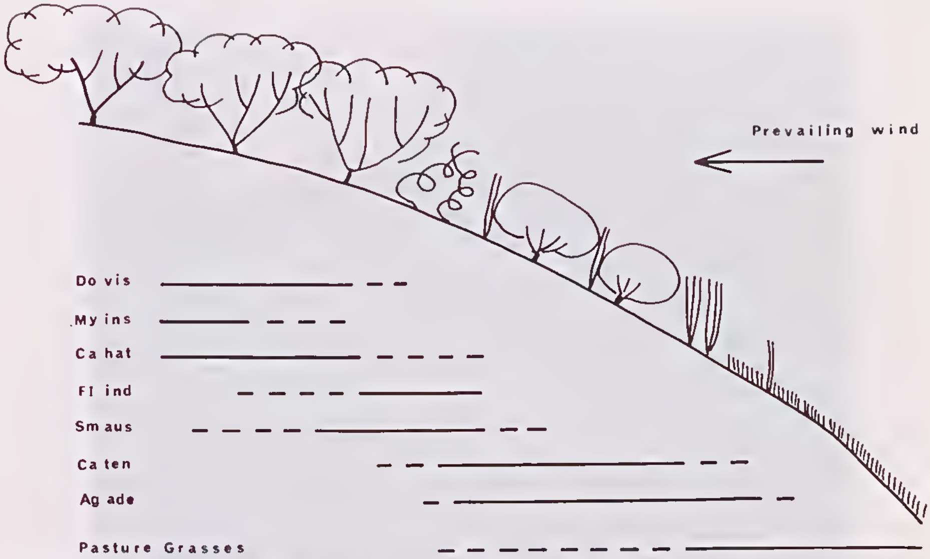

Figure 28. Diagrammatic cross-section of pastures in Portion 130 being invaded by shrubs (see Figure 27). Horizontal lines indicate range of occurrence of the following species:

Do vis	*Dodonaea viscosa*	Sm aus	*Smilax australis*
My ins	*Myoporum insulare*	Ca ten	*Cassinia tenuifolia*
Ca hat	*Carex hattoriana*	Ag ade	*Ageratina adenophora*
Fl ind	*Flagellaria indica*		

ran over Windy Ridge through *Drypetes-Cryptocarya* forest about 5 m high. A narrow strip of vegetation was cleared along the power line to stop branches hitting the wires. Continual cutting was required to minimise regrowth along the strip and arrest the succession. The response of the vegetation was a dense tangle of the vines *Flagellaria indica* and *Smilax australis.* Similar vine tangles are common elsewhere on Lord Howe in natural light-breaks or under sparse canopies.

Portion 130 runs from swampy flats beside Soldier Creek up onto a steep north-facing basalt slope which is exposed to winds. The original cover on the slope, *Dodonaea viscosa* scrub, has been substantially cleared for a pasture of stoloniferous grasses and herbs (Figure 27). As the 1923 map shows the clearing, the paddock is at least 50 years old. *Dodonaea* is colonizing the eastern edge of the paddock (Figures 27 and 28). *Cassinia* and *Ageratina* are also invading and are very dense at the edge, but neither penetrates far into the *Dodonaea.* A tangle of the vines *Flagellaria* and *Smilax* occurs between bushes of *Cassinia.* The western side of the paddock is in a gully and abuts *Drypetes-Cryptocarya* rainforest. Here it is more sheltered and consequently *Cassinia* does not mark the edge. Instead there are various young trees from the forest: *Dysoxylon, Polyscias, Howea forsterana* and *Guioa. Cassinia* is invading several other exposed abandoned clearings: The Rib, above Mosely Park, and on a site cleared for airstrip fill near Salmon Beach. On Peach Tree Ridge below Intermediate Hill, a comparable pattern occurs but with *Myoporum insulare* instead of *Cassinia.* The Red Ground is being invaded by both *Cassinia* and *Myoporum.* In all these clearings, pasture is being invaded when cattle grazing is either reduced or stopped.

Retmocks Garden on the northern side of Windy Ridge has a chequered history. A resident cleared some *Drypetes-Cryptocarya* forest for a fruit garden. At about the same time, a second garden was cleared next to, but separated from the first by a thin strip of trees. Onions were grown in this second garden. When Retmock took over both gardens he removed these trees and used the whole garden for fruit until abandoning it about 1940. Today it is a series of dense thickets of Cherry Guava (*Psidium cattleianum*) and Guava *(P. guajava)* (Figure 29). A few peaches (*Prunus*

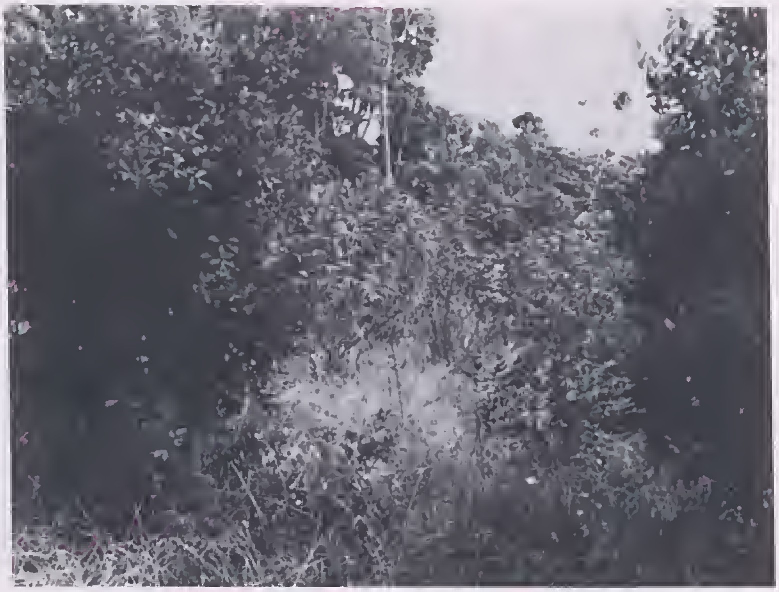

Figure 29. Cherry Guava (*Psidium cattleianum*) invading Retmocks Garden.

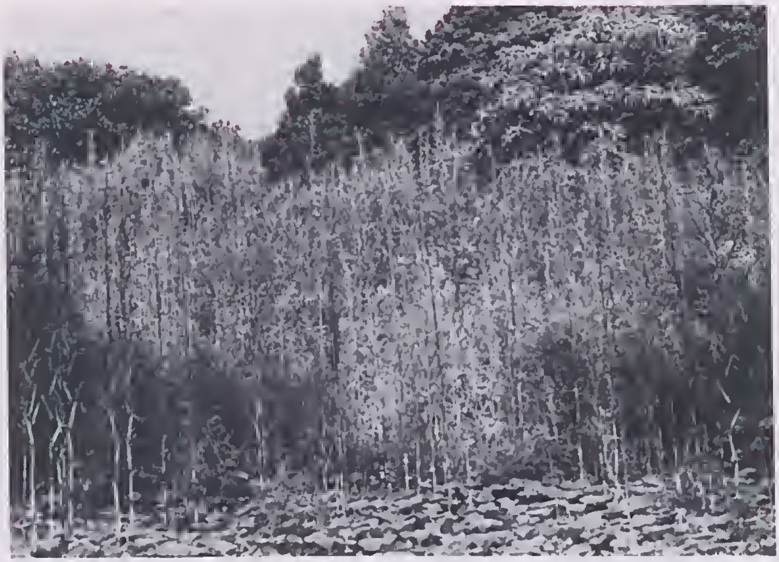

Figure 30. Bamboo (*Phyllostachys aureus*) invading Valley Garden. Cultivated cucurbits in the foreground.

persica) and Rough Lemon (*Citrus limonia*) remain from the original planting. Rough Lemons were used as root-stocks for oranges and mandarins and have probably taken over from them when the trees were neglected. *Paspalum* and *Pennisetum* form a dense ground cover with various introduced herbs: *Bidens, Verbena* and *Gnaphalium* spp. The garden is a good example of many gardens elsewhere on the island that are neglected or poorly managed, for example, Banyan Garden.

A comparable situation involving different species occurs in Valley Garden. This is in a solution doline on the junction between the basalt and calcarenite. As it is

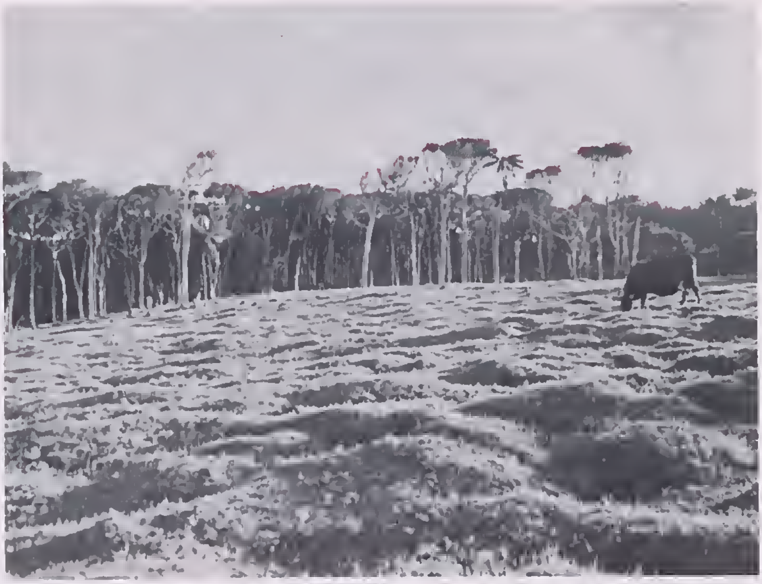

Figure 31. Grazing paddock of *Pennisetum clandestinum* near Jims Point showing the lack of regeneration of forest caused by cattle grazing and intense competition by *Pennisetum*. Nesting Fleshy-footed Shearwaters (*Puffinus carneipes*) cause the hummocky microrelief. The paddock is within the Big Mutton Bird Ground.

very sheltered and the soil is enriched from the basalt slopes it is an ideal site for a garden. The original vegetation on calcarenite was *Howea forsterana* with many *Ficus* and *Celtis*. The ground cover would have been variable because of nesting Fleshy-footed Shearwaters (*Puffinus carneipes*). The basalt slopes on the south are steeper and support dense forest of *Drypetes-Cryptocarya*. W. Whiting apparently cleared the basin some time after 1912 to plant oranges. Before abandoning it in 1939 he planted the bamboo *Phyllostachys aureus* on the eastern side. From 1939 to 1981 various residents have used the garden and now bananas, pumpkins and other vegetables are grown there with some of the orange trees planted by Whiting. However, by 1981, *Phyllostachys* had spread vegetatively across the garden, to cover more than three quarters of the original clearing (Figure 30). It had not yet spread into the adjoining forests. It is dominating other weeds such as *Duchesnea, Solanum mauritianum,* and *Tropaeolum*. Thin vines such as *Stephania* and *Parsonsia* form a tangle about 1 m deep over the whole basin.

A steady state between forest and grass exists at Fred Nichols Garden behind North Beach. In 1840 Captain Middleton settled at the foot of Mount Eliza and Foulis' 1851 map (Foulis, 1853) shows a clearing there. Subsequently in 1898 and 1923 it was marked on maps as a garden. Today the garden remains as a 50 m square patch of Rhodes Grass (*Chloris gayana*) in the *Howea forsterana* forest. The dense *Chloris* up to 0.75 m tall effectively stops palm regeneration, and shade in the dense *Howea* forest stops the *Chloris* spreading.

Above Stevens Point is an excellent example of a steady state maintained by cattle and a fence. The area, which is part of the Big Mutton Bird Ground described above, was originally *Howea forsterana* forest on calcarenite soil. Fleshy-footed Shearwaters nest throughout the area on both sides of the fence (Figures 23 and 31). Cattle eat any Howeas within reach through the fence (Figure 32) and kill any seedlings which germinate in the *Pennisetum clandestinum* pasture (Pickard, unpublished data). *Pennisetum* has invaded the palm forest for a short distance, presumably stopping when light becomes limiting.

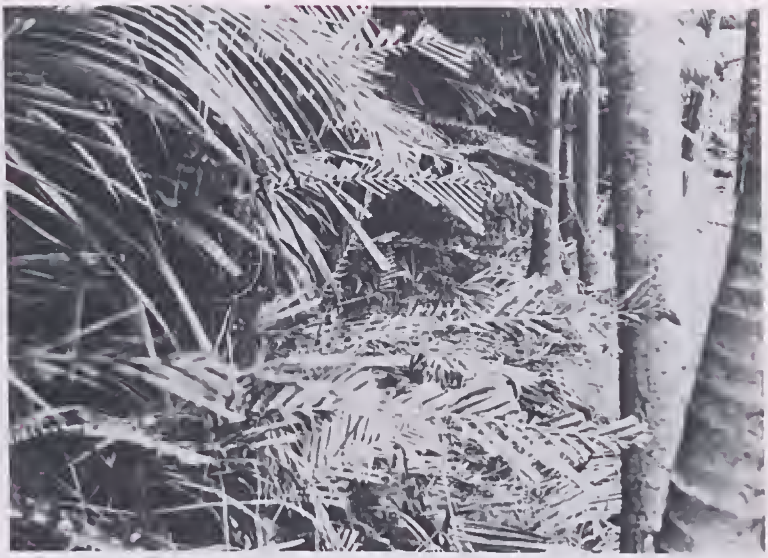

Figure 32. *Howea forsterana* eaten by cattle leaning over the fence (right, strung between tree-trunks). In the grazing paddock (upper right) there are no young *Howea*. Paddock near Salmon Beach.

This and other steady states are maintained by the combination of cattle and fence; they can be altered by any of a number of changes. The simplest is to remove the fence and allow the cattle to graze unhindered. Fences are rarely removed on the island to allow cattle free grazing but poor maintenance and broken fences lead to the same result. The cattle kill young plants and the pasture spreads (Figure 33). Alternatively, the cattle could be removed, but the resultant changes are not so simple to predict. Where the grazed area is surrounded by ungrazed forest or if a large number of the original trees remain, regeneration of the vegetation may be rapid (Figures 34 and 35). However, if the area is very close to other grazing paddocks with

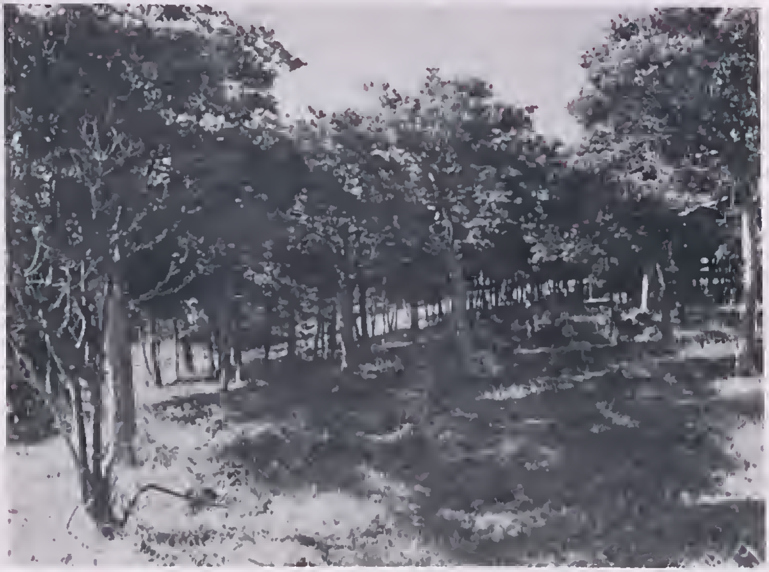

Figure 33. Loss of shrub understorey in *Drypetes australasica-Cryptocarya triplinervis* forest near Soldier or Big Creek, because of moderate cattle grazing.

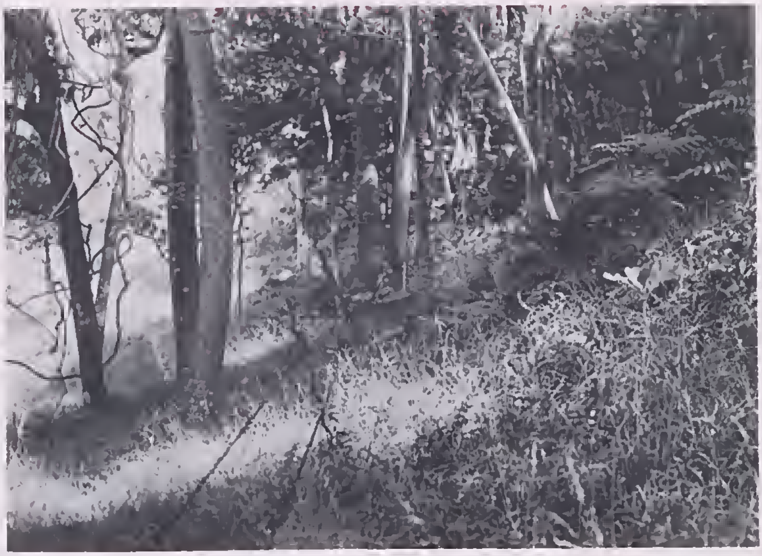

Figure 34. Regeneration of grazed forest can be rapid if sufficient seed sources remain and the forest is not invaded by *Pennisetum* or *Stenotaphrum*. Ten years after fencing to exclude cattle this *Drypetes australasica-Cryptocarya triplinervis* forest on the ridge north of Soldier or Big Creek has a well-developed understorey of shrubs, ferns and herbs.

Pennisetum or *Stenotaphrum* then regeneration is very slow. *Pennisetum* is a fast-growing grass which, if ungrazed, quickly forms dense swards up to 1 m deep (Figure 47). Under these conditions, germination and establishment by any other plant is markedly reduced. Even species with large seeds, such as *Howea* and *Drypetes*, almost invariably fail. Consequently, the present pasture/forest boundary would remain unaltered for a long time. This is analogous to the boundary between the *Chloris/Howea* at Fred Nichols Garden described above.

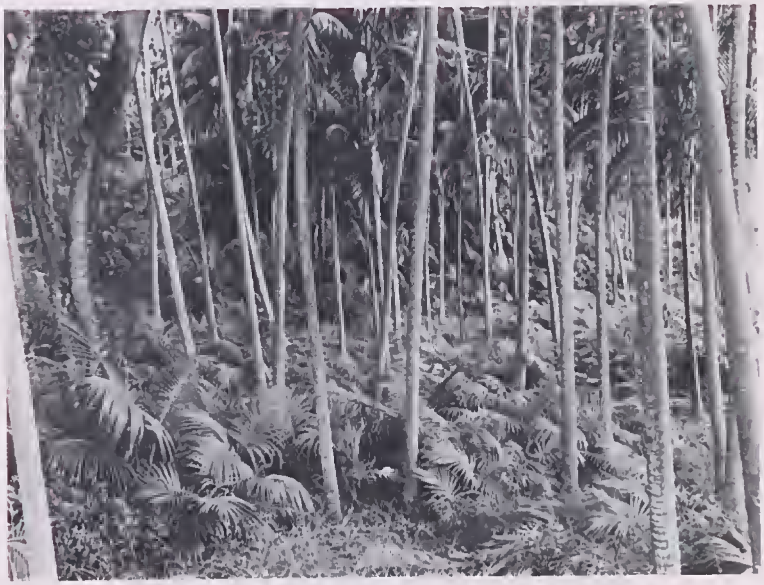

Figure 35. Bimodal age distribution in *Howea forsterana* forest near Salmon Beach. Several decades of cattle grazing had destroyed all the small plants of *Howea* and other species. Because there are no adjacent paddocks with *Pennisetum* or *Stenotaphrum* the palms were able to regenerate from seed.

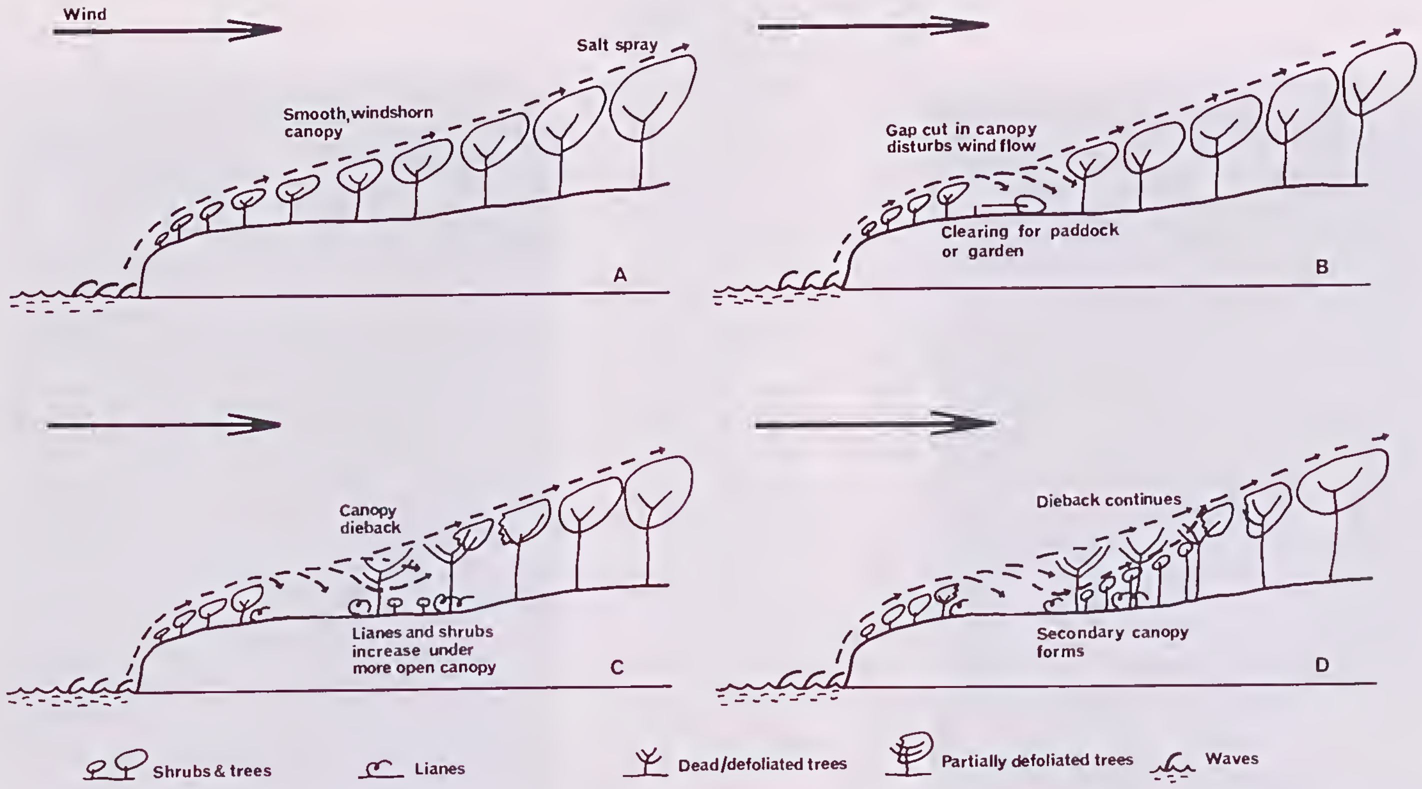
Wind
Salt spray
Smooth, windshorn canopy
A
Gap cut in canopy disturbs wind flow
Clearing for paddock or garden
B
Canopy dieback
Lianes and shrubs increase under more open canopy
C
Dieback continues
Secondary canopy forms
D
Shrubs & trees
Lianes
Dead/defoliated trees
Partially defoliated trees
Waves

Figure 36. Secondary canopy formation in coastal forest disturbed by a clearing (A). Wind-borne salt blows through the previously intact canopy and starts progressive die-back of the canopy trees (B, Figure 37). Lianes and shrubs respond to the increased light by forming dense tangles (C, Figures 37, 38). Young canopy plants grow up through the shelter of these tangles and form a secondary canopy (D, Figure 39). This rises from the ground level at the edge of the clearing up to the original canopy. As long as the clearing remains unchanged, the secondary canopy will persist, but if the wind flow is altered again by altering the shape or size of the clearing, then a new secondary canopy will form.

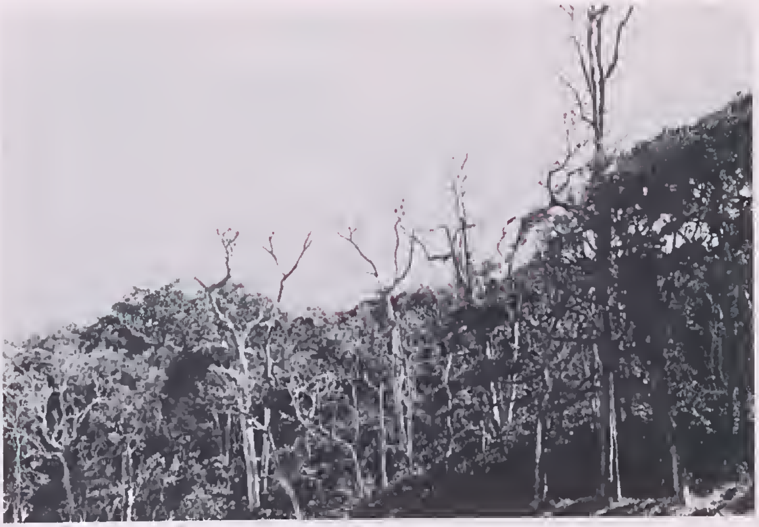

Figure 37. Canopy dieback in *Cleistocalyx fullagari* and *Drypetes australasica* on the edge of a clearing on the exposed ridge below and west of Middle Beach Common. Shrubs, lianes and young canopy plants are forming a dense tangle out of reach of grazing cattle just beyond a fence (foreground).

Perhaps the most complex situation occurs on moderately exposed forest sites which are cleared or grazed. The interaction between wind, cattle, and shade stimulates the formation of what I call "secondary canopy". It is usually initiated by clearing and subsequent exposure of a wall of fresh or unconditioned vegetation to wind. If the clearing is small, then the wind streamlines are apparently unaffected and no damage occurs. But if the width is greater than 1 to 1½ times the height of the canopy, then the wind blows through the vegetation on the lee side of the clearing (Figure 36). Leaves on the exposed trees die giving the "die-back" (Figure 37) reported by

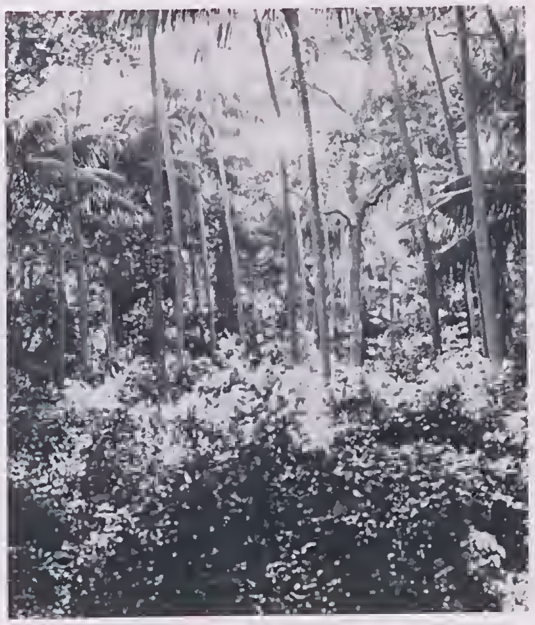

Figure 38. Tangle of lianes over shrubs and young trees in *Howea forsterana* forest about 10 m from the edge of the clearing in Figure 37.

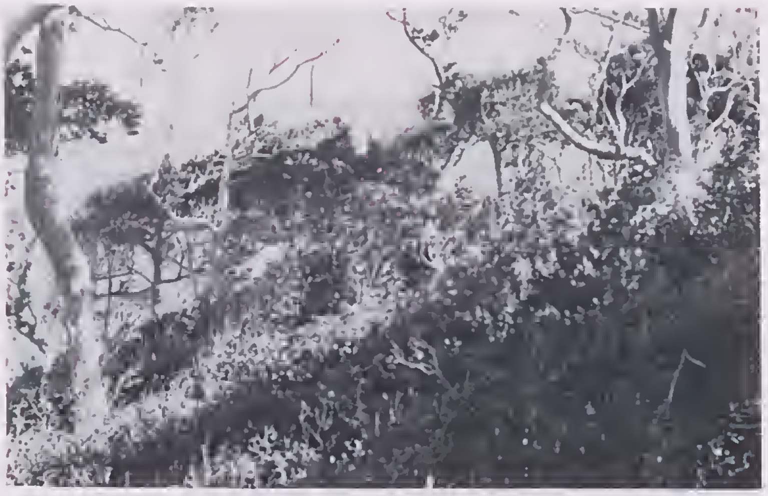

Figure 39. Steeply rising secondary canopy in *Drypetes australasica-Cryptocarya triplinervis* forest near the edge of the clearing shown in Figures 37 and 38.

all observers from Foulis (1853) on. This allows more light to penetrate the canopy and a vine entanglement or shrubby understorey to develop (Figure 38). The height of this tangle is determined by the wind, so that it is lowest next to the clearing and rises into the forest. As seedlings of canopy plants grow, they form a new canopy line rising at a steep angle from the edge of the clearing up to the original canopy (Figure 39). This is the "secondary canopy". If the clearing is abandoned, then an old field succession would occur leading to eventual recovery of the original canopy line. As this line is an integrated long-term response to the wind, if the wind regime does not change, a similar line will be attained when succession is complete. Locally, for example, between "Pine Trees" guest house and Windy Point, up to three planes or secondary canopies have developed (Figure 40) in response to obstruction to wind flow leading to slightly different wind streaming patterns.

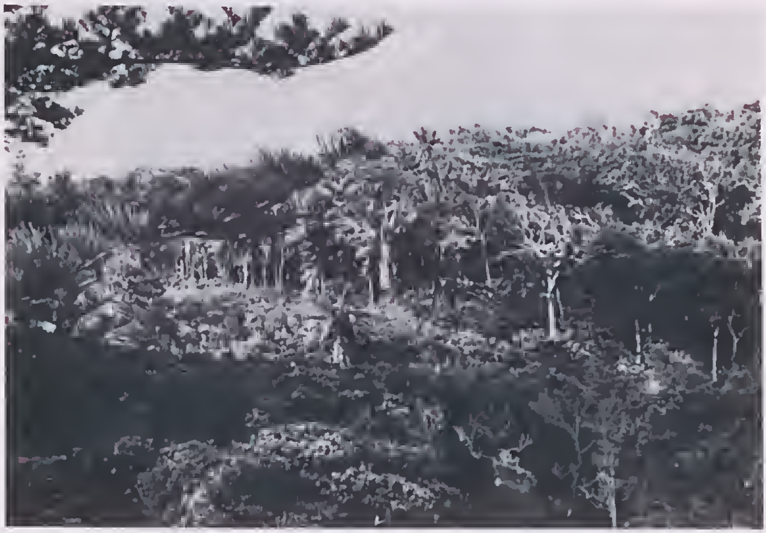

Figure 40. Wind flow around obstructions immediately north of Windy Point has lead to three planes of secondary canopy, after road construction and clearing on the windward side had exposed previously sheltered *Drypetes australasica-Cryptocarya triplinervis* forest.

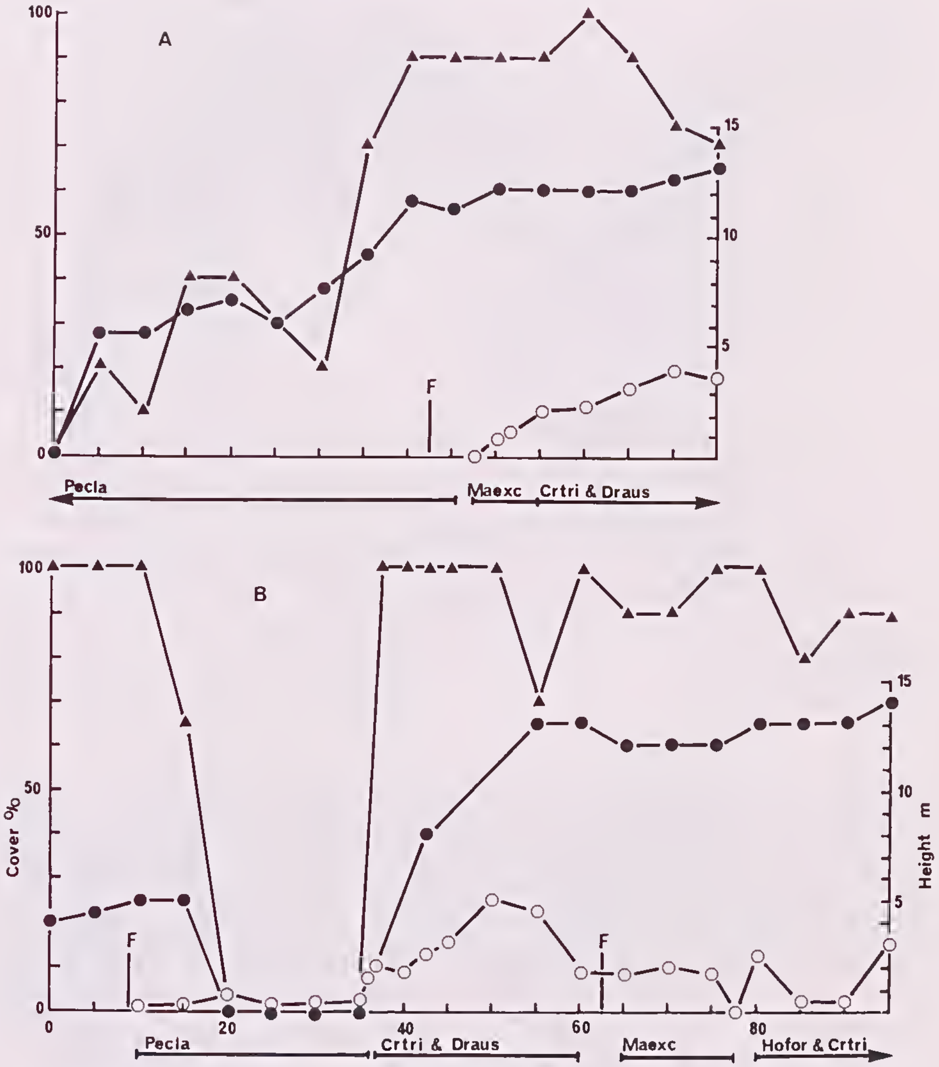

Figure 41. Distribution of canopy cover (▲), canopy height (●), and secondary canopy height (○) on two transects, A and B, measured above the south end of Middle Beach. Cattle graze to the left of the fences (F) on transect A, and between the fences on transect B. Solid lines under the figures indicate the distribution of the major secondary canopy species:

Crtri	*Cryptocarya triplinervis*	Maexc	*Macropiper excelsum* var. *psittacorum*
Draus	*Drypetes australasica*	Pecla	*Pennisetum clandestinum*
Hofor	*Howea forsterana*		

If grazing continues in the clearing then the results are not as simple and may be further complicated by fences. Two transects were measured on calcarenite soils above Middle Beach at the southern end of the Big Mutton Bird Ground. *Drypetes-Cryptocarya* forest has been grazed for many years and has been fenced since at least 1923 (Ferrier, 1923). Canopy height and cover, and secondary canopy height were measured at 5 m intervals on the transects (Figure 41).

On both transects the secondary canopy rises steeply towards the original canopy but does not reach it before falling again. The species measured are all canopy trees

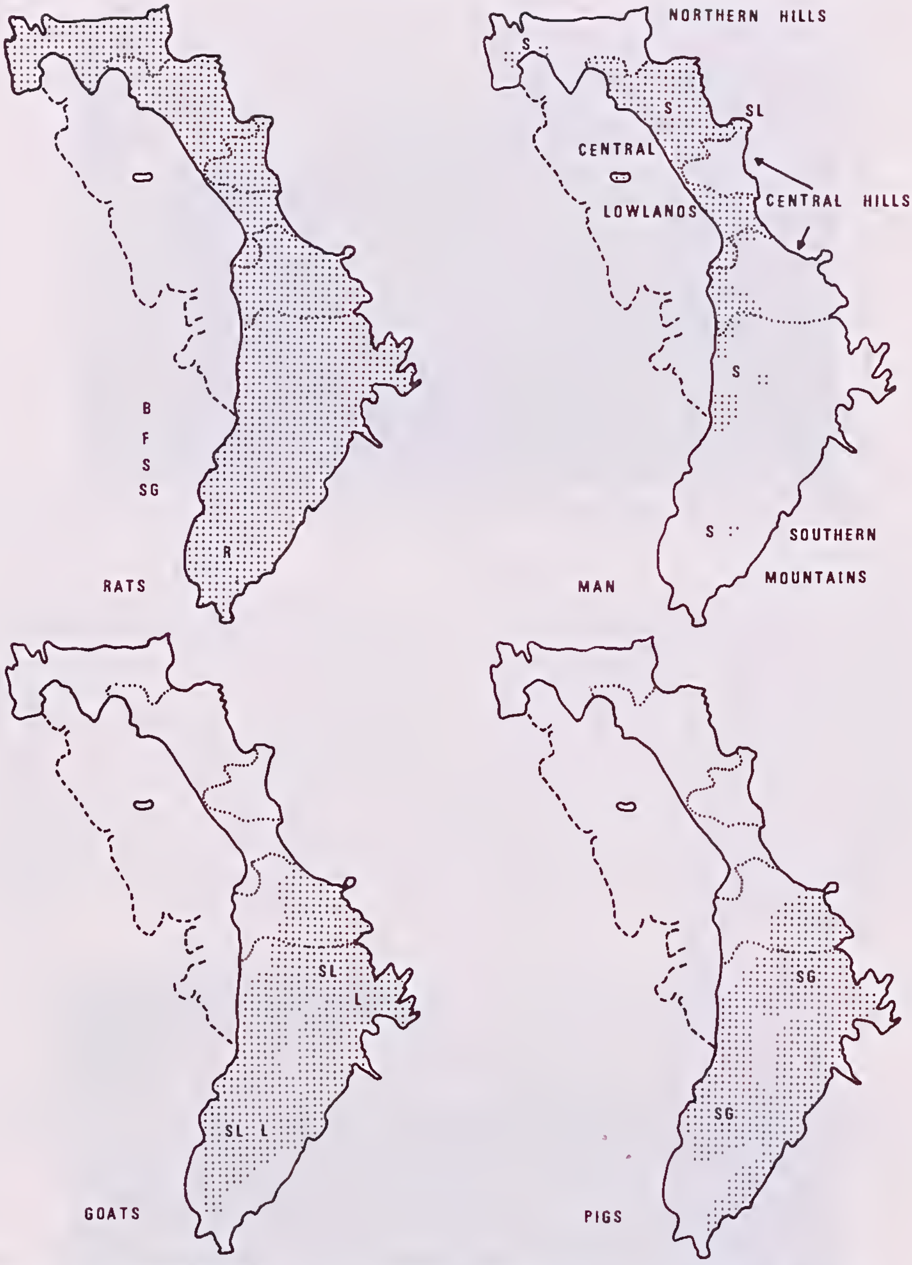

Figure 42. Generalized distribution of five animal predators (stippled) on the plams showing the parts of the plams (letters) attacked in different physiographic regions of the island. Insects are ubiquitous and are not shown. Distribution map for goats omits northern hills population which was exterminated in 1977. Not all palm-seeding areas are shown on the map for man. Different areas are harvested every few years, those shown being the major seeding areas. The four physiographic regions are described on pages 136-140.

Abbreviations and symbols

B	Flower buds	SL	Seedlings
F	Flowers	R	Rhachises
S	Seeds (on trees)	L	Leaves
SG	Seeds (on ground)		

. . . Boundaries of physiographic regions

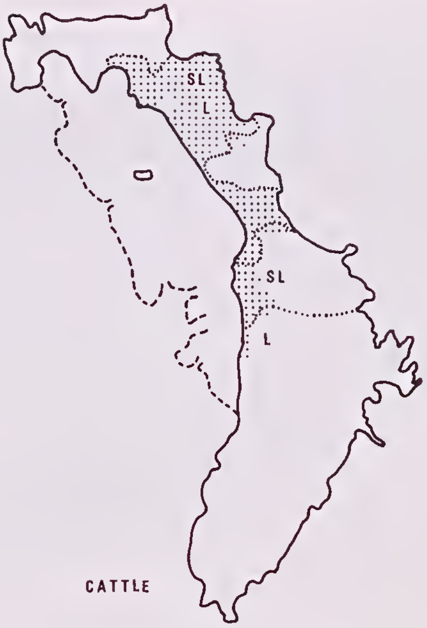

Figure 42 continued.

except for *Macropiper excelsum* var. *psittocorum*. *Macropiper* is a common understorey woody herb/shrub on the island, usually found in light breaks. The fenceline effect is more prominent on transect A than on transect B. On the former, *Pennisetum* barely penetrates the ungrazed forest but on the latter it does not. Transect B is somewhat unusual as some young canopy plants are inside the grazed area. Presumably, at some time in the past, cattle were not grazed in the paddock, and the *Cryptocarya* and *Drypetes* established inside the edge of the canopy where there was no competition from *Pennisetum*.

Palm-seeding and the palm forests

Harvesting and exporting of palm seeds began about 1890 and, with some interruptions, has continued to the present day. Basic information on the industry and seed yields is given in Pickard (1980). Four species are harvested; the quantities harvested are always in the order *Howea forsterana, H. belmoreana, Hedyscepe canterburyana* and *Lepidorrhachis mooreana*. Before the harvesting commenced the only predators on the palms were presumably insects; but now insects, rats, goats, cattle, pigs and man all attack the palms at various stages of growth.

The question I consider here is whether this combined predation is jeopardizing the long-term future of the palm forests. I shall only discuss *Howea forsterana* as the pressures on the other three species are considerably lower. The simple answer to the question is that undisturbed forests appear to be coping with predation, that is, there is adequate replacement of old trees. In stands disturbed by clearing and, or grazing, existing palms are not being replaced as they die.

To clarify this we need to consider those stages of the life history of the palm that are attacked (Figure 42). Insects attack buds, flowers, seeds and the trunks, but to an unknown degree. The palm forests and insects have coexisted on the island for a considerable time so they are probably in equilibrium. Rats eat every part of the palm except the leaves and trunk. Field evidence indicates that seeds are the most attractive to rats. Cattle and goats eat seedlings and leaves within reach. Fallen seeds are eaten by pigs. Finally, man harvests seeds and seedlings but also fells trees for clearings. The proportional effect of each animal depends on the location: in grazing paddocks, cattle predominate; in sparse stands in the northern hills, rats and goats; in sparse stands in the southern mountains, rats, goats and pigs; in dense accessible stands, rats, goats, man and pigs.

Only in paddocks grazed by cattle is there no sign of young and seedling palms (Figure 31). Thus it is clear that in these disturbed situations cattle, rather than rats or man, are limiting regeneration. In "undisturbed" areas where palms are attacked by rats, man, goats and pigs, there is a variable number of seedlings and young palms. For example in the Grey Face seeding area there are 826 ± 2145 seedlings* and 667 ± 635 saplings/ha (Pickard 1980, unpublished data) measured in 15, 5 m square quadrats. In the Clear Place seeding area at Valley of the Shadows there are sufficient seedlings that these are now being harvested.

Pigs and goats appear to be unimportant except locally. In the special case of Little Slope, where goats were much more abundant than usual, they removed all young plants of *Howea forsterana*. Clearly then, man only harvests the seeds which the rats leave; cattle, goats and pigs eat seeds and seedlings that escape both rats and man. The inherent difficulties of palm-seeding mean that only high-yielding and accessible palms are harvested. Fewer than 10 per cent of 300 trees in seeding areas measured each year for three years had seed yields exceeding 4 kg (Pickard, 1980). As most of these trees are subject to continual predation by rats, the remaining seeds are available for regeneration, which leaves ample stock for replacement of old palms.

I can see no reason why some island residents and conservationists assert that present levels of seed and seedling harvesting are detrimental to the forests. Available evidence shows that cattle grazing in paddocks, which are frequently poorly fenced, are the real problem. Better management, such as fencing off small enclosures, planting young palms and improving boundary fences would prevent deterioration of these areas. Rats are a different proposition. They are ubiquitous, omnivorous and virtually impossible to eliminate. Despite this, there is little evidence that the combined pressure of 60 years of rats' and 90 years of mans' predation have damaged the forests over most of the island. Rats have, however, seriously reduced the number of seeds available for harvest.

If future research demonstrates that harvesting is causing deterioration, seeding from natural stands should be phased out in favour of plantations. Suitable sites occur on seldom-used and unproductive grazing paddocks. In fact, there is considerable merit in this even if deterioration cannot be proven. Palms grown from seeds selected from trees known to be high-yielding should have higher-than-average yields when cultivated. Rat control would be simpler, cheaper and more effective in plantations than natural forests. This is a relatively simple and cheap method of effectively reducing pressure on the natural forests and increasing the total harvest and income.

Construction

Basalt and calcarenite have been quarried at several sites on the island for construction material. More recently the airstrip was built using both local and imported raw materials. The combined effect of all these quarries is quite low, but the sites show a range of responses. The critical factor is not the rock type but whether the adjacent area is disturbed. Quarries in or next to grazing paddocks or similar

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*Seedlings defined as *Howea forsterana* up to 1 m high, saplings as up to 2 m but without a trunk.

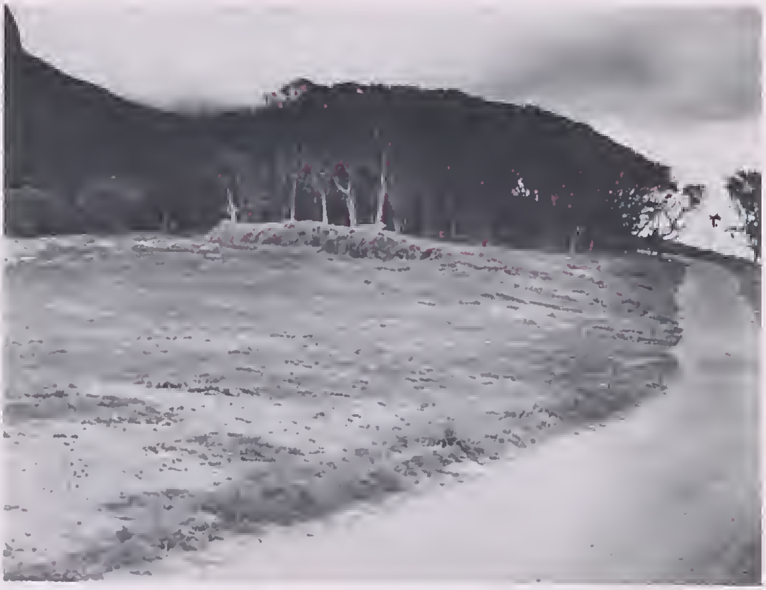

Figure 43. Kirribilli was quarried for fill for the airstrip in 1975. Introduced grasses, particularly *Pennisetum* and *Stenotaphrum*, were allowed to colonize the area which adjoins the golf course (on the left). The stand of *Drypetes australasica-Cryptocarya triplinervis* forest in the rear is now exposed to winds and will very quickly start to die back.

grassed areas are colonized by the pasture grasses, usually *Pennisetum* or *Stenotaphrum*. Examples on calcarenite are at Neds Beach, Middle Beach Road and Kirribilli (Figure 43); on basalt at Windy Point and above Lovers Bay. In each case the quarry is invaded by the grasses although some other species also occur.

If the quarry is surrounded by essentially undisturbed vegetation, then it will be invaded by seedlings of native species and very few weeds. Small calcarenite quarries on Anderson and Middle Beach Roads are both recolonized by the surrounding forest species, for example, *Drypetes australasica, Cryptocarya triplinervis, Planchonella myrsinoides* and *Asplenium oblongifolium*. The largest quarry site on the island was cleared but never actually exploited. The Wood Paddock near Salmon Beach was intended as a source of basalt for construction of the airstrip in 1975. The forest was cleared, a few test trenches were dug, but the site was abandoned. No efforts have been made to restore the vegetation, but colonization until 1978 was by a mixture of mostly native species with some exotics. Provided the aggressive grasses do not become established the original vegetation should regenerate. By 1981, the proportions had changed considerably, with *Pennisetum* becoming dominant, particularly on the western portion of the site.

The airstrip was built on the low, flat ground south of Transit Hill. The corner of a relatively undisturbed *Drypetes-Cryptocarya* stand was cleared and the remainder exposed to the wind. The consequences are exactly as could be expected: progressive crown die-back, and vine tangles and secondary canopy formation. The stand of *Lagunaria patersonia* in the swamp behind the Blinky Beach sand dune was destroyed to improve safety (Figure 44). The top of the calcareous sand dune at Blinky Beach was removed to improve the safety for aircraft taking-off and landing. It was restored and planted with *Spinifex hirsutus* to stop sand drift. Restoration has been successful, drift is minimal. However, while *S. hirsutus* is a native grass and occurs on the sand-dune, most of the material planted was imported from the north coast of New South Wales (Soil Conservation Service of NSW, pers. comm.; R. Shick, pers. comm.). Any unique genetic differences in the Lord Howe population are now contaminated.

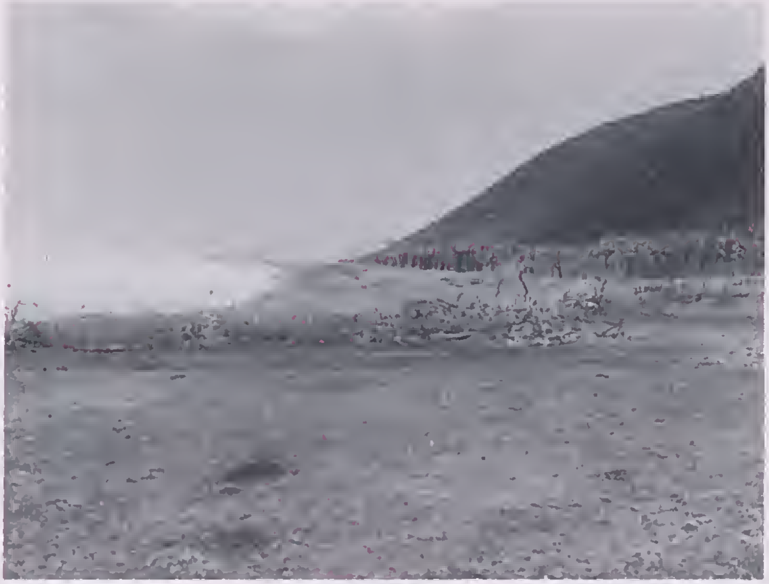

Figure 44. Remains of the *Lagunaria patersonia* swamp forest in Moseley Park after it had been cut down to improve safety at the southeast end of the airstrip in 1975. Compare with the photograph on p.178.

Tourism and attempts at aesthetic improvement

Some 4–5 000 tourists visit Lord Howe Island each year (Ashton, 1974). Although no visitor surveys have been conducted, it is obvious from talking to visitors that a large number come for the scenery, flora and birds (Figures 18, 19). The scenery is a mixture of forested hills and mountains, verdant grazing paddocks and ever-changing seascapes. What has been the effect of several decades of tourism on the environment?

The direct effects of tourists are minimal; most damage is a consequence of attempts to improve the scenery. The practice, if not the policy, of the Lord Howe Island Board from 1955 to 1978 has been to modify and destroy the natural vegetation, presumably in the belief that such modification enhances the beauty of the island. In 1963 native scrub on the hind-dune opposite the school was cleared and 200 New Zealand Christmas Bushes (*Metrosideros excelsa*) were planted in 1964 (Annual Report of the Lord Howe Island Board 1963, 1964). In 1981, 18 years after the shrubs were planted, the area is a closely mown turf of *Stenotaphrum secundatum* and *Pennisetum clandestinum* with some of the *Metrosideros* still surviving (Figure 45). Onshore winds have inhibited growth of the *Metrosideros* on the exposed shore. Further inland, the seaward edge of the native forest is exhibiting symptoms of die-back first described over 100 years earlier by Foulis (1853). Not only was the experience of the effects of foreshore clearing ignored but also the possibility of hybridization between the exotic *Metrosideros excelsa* and the two endemic species *M. nervulosa* and *M. villosa*. More recently the Board has attempted to correct this mistake and is now replanting various native species in the shelter of remnant shrubs. By 1981 several of these plantings were well-advanced demonstrating that restoration is possible. However, some island residents are still planting exotic plants such as *Nerium oleander* and *Erythrina* x *sykesii* on the foreshore about 300 m away (Figure 46).

Pennisetum clandestinum (Kikuyu Grass) and *Stenotaphrum secundatum* (Buffalo Grass) are the most abundant and widespread pasture grasses on the island.

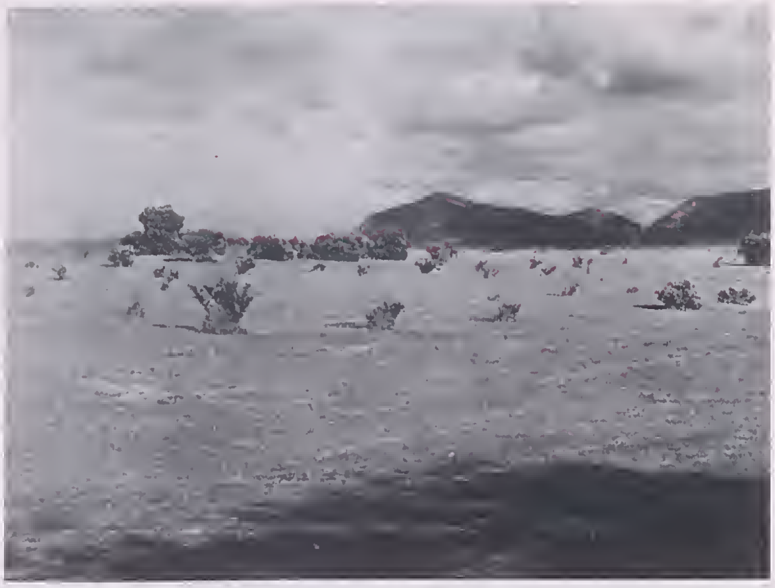

Figure 45. From 1955 to 1960, the hind-dune scrub was cleared from Lagoon Beach opposite the playing field and replaced with planted New Zealand Christmas Bush (*Metrosideros excelsa*). After nearly 20 years the bushes have scarcely grown. Regular mowing to maintain the lawn of introduced grasses prevents recolonization by native vegetation. More recently, the Board has begun a programme of replanting native shrubs and trees in this area.

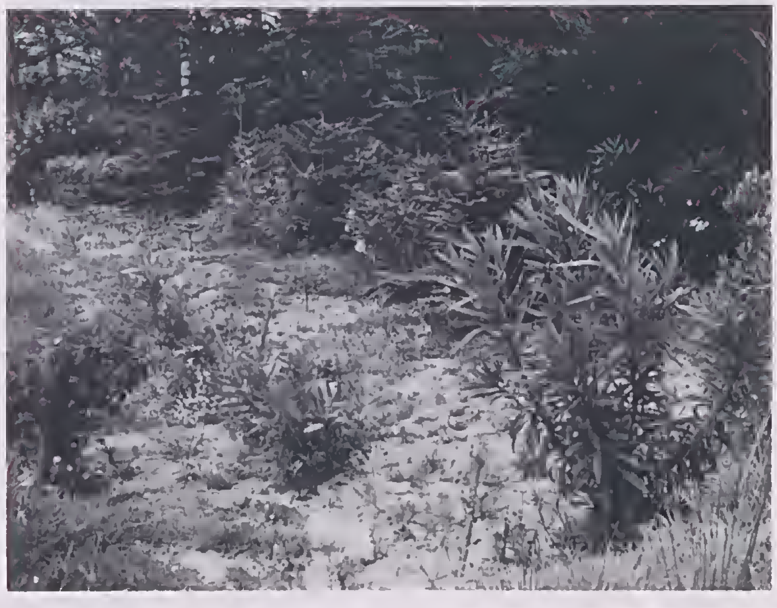

Figure 46. An island resident cleared hind-dune vegetation behind Lagoon Beach near the main settlement to plant the area with exotics such as Oleander (*Nerium oleander*) and Coral Tree (*Erythrina* x *sykesii*). Norfolk Island Pines (*Araucaria heterophylla*) on the right were planted over 100 years ago.

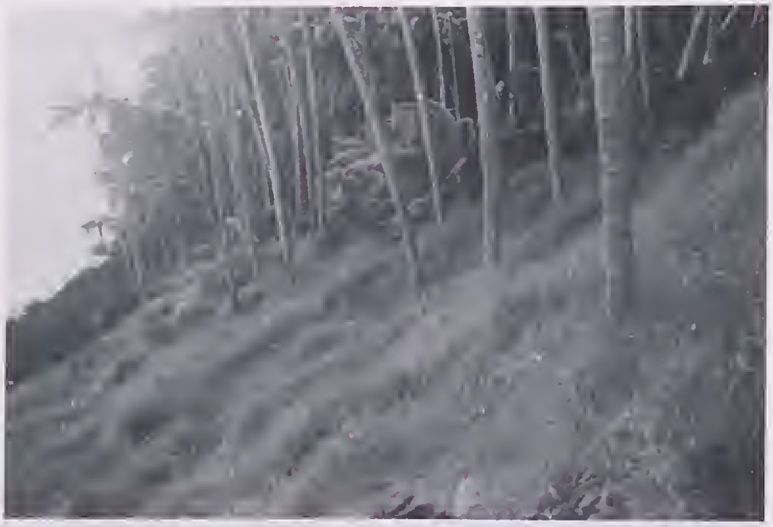

Figure 47. There has been a belief that every patch of eroding soil on the island requires stabilizing and some residents have planted stolons of *Pennisetum clandestinum* to arrest what is a natural process. On Little Slope, this patch of *Pennisetum* just above the shore is spreading into the *Howea forsterana* forest and, if it continues unchecked, will spread along the length of Little Slope and become impossible to eradicate.

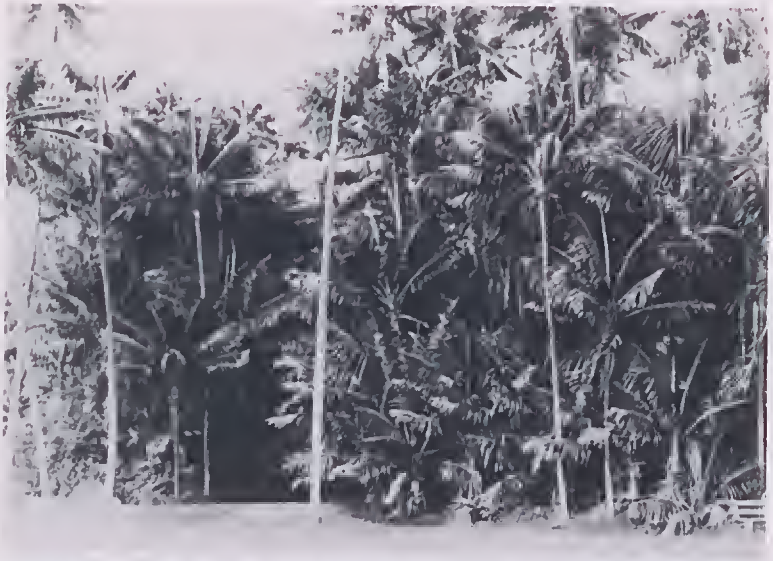

Figure 48. Behind Neds Beach the *Howea forsterana* forest at the northern end of the Big Mutton Bird Ground stops abruptly at the edge of regularly mown *Pennisetum clandestinum*. Lawns like this are common in the main settlement area of the island and frequent mowing prevents any regeneration of native trees. The dense palm forest is not invaded by the grass, presumably because there is insufficient light.

Both spread vegetatively and now cover most disturbed road verges, and similar sites. If left unchecked, the grasses grow into a tangled mass up to 1 m deep to the exclusion of other small plants (Figures 47, 49). When they are mown, they form attractive lawns (Figures 5, 48) and when grazed in paddocks, a rough pasture results (Figure 31).

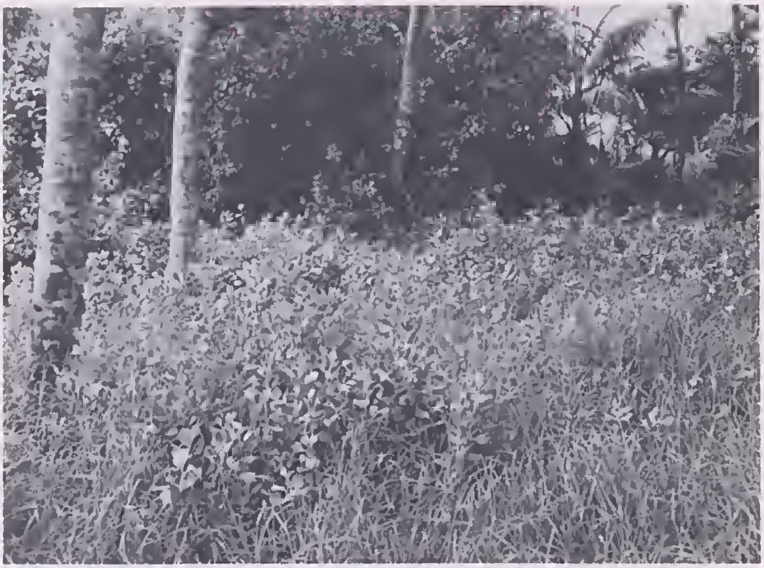

Figure 49. Dense growth of *Chrysanthemoides monilifera* and *Pennisetum clandestinum* about 1 m high under *Drypetes australasica-Cryptocarya triplinervis* behind Lagoon Beach near the airstrip terminal.

Unrestricted mowing to maintain the lawns prevents regeneration because it kills any seedlings. However, the same effect results from no mowing because the vigorous grasses suppress seedlings by competition. There is no simple solution to the problem of regeneration of the infested areas. Some patches may be treated with herbicide and natural regeneration allowed, but this would be successful only in small isolated areas surrounded by an adequate source of seed of native plants. *Pennisetum* has been deliberately planted in several places because residents are unable to accept that erosion is a natural process and is not necessarily "bad". Small patches on Mutton Bird Point, Little Slope (Figure 47), and the Get-up Place on the track to Mount Gower, and the Lower Road were all planted to stop erosion. *Pennisetum* now covers virtually the entire summit of Mutton Bird Point, having spread rapidly from 1970 to 1980. The other sites serve as foci for the spread of the grass into adjacent uninfested vegetation. Herbicide treatment may be successful on these sites as they are isolated, and there are adequate seed sources for colonization by native species.

Several ornamental plants have become naturalized in both disturbed and undisturbed vegetation. Boneseed (*Chrysanthemoides monilifera*) was introduced to the island about 1935 as a garden plant and escaped to a few scattered sites along Lagoon Beach. The populations were static for many years but rapidly expanded after 1970 (Figure 49). Since 1975 the Board has been trying to eradicate the plant by tractor- and hand-pulling (Figure 50). This may lead to other problems, for example, invasion of the disturbed soil by *Pennisetum* or a number of other weeds. Tiger Lily (*Lilium formosanum*) was also introduced as an ornamental, but escaped; the plants flower profusely and seed prolifically. Like many other weeds, *Lilium* has spread south rather than north and is now firmly established in the southern mountains.

Boats, once essential for the island's economy, are now mostly used in the tourist industry. One exception is the lighters used for unloading cargo ships which anchor off the island. The main public jetty in the lagoon is frequently used, and some residents believe that turbulence created by boats is damaging the *Zostera-Halophila* community on the lagoon floor. I examined the community at several places including the jetty and saw no evidence of damage due to boats. In fact, some of the tallest and densest stands occur at the end of the jetty where the traffic is heaviest.

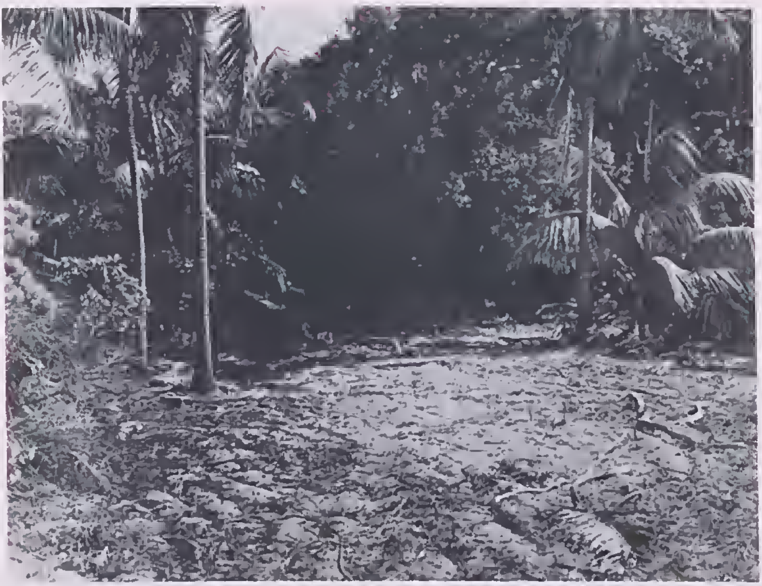

Figure 50. Since 1975 the Board has unsuccessfully tried to eradicate *Chrysanthemoides monilifera* from the island. This was a very dense stand of the shrub on the dune behind Lagoon Beach about 200 m south of the end of the airstrip. Because it was so dense and the individual plants so large, pulling with a tractor was necessary. However, the disturbed soil surface is an ideal seed bed for other weeds, and other methods of eradication may be indicated.

In December 1902, Edgar Waite (1902) commented on the community in Hunter Bay "at the north end of Lagoon are small masses of seaweed [sic] 3 or 4 feet in diameter. These wave their crest about in the wash of the waves and at low tide are barely covered." Today, the stands are virtually identical and there appears to be no evidence of disturbance (photograph, p.212).

THE FUTURE OF THE VEGETATION

The aim of this study was to describe and map the vegetation of Lord Howe Island. The description would be incomplete without some consideration of the future of the vegetation particularly as it could be affected by management decisions. I have discussed the effects of past management above; these have mostly been deleterious. Perhaps the major threat to the vegetation is from progressive dieback adjacent to clearings. Although it was recognized over 100 years ago, it is still largely ignored as a problem. In 1978 the Lord Howe Island Board commenced replanting native species on a few foreshore areas denuded of trees. This approach has been successful and should be extended to other areas on the island.

Tourists provide by far the largest income to the island. Many tourists come to look at a relatively undisturbed island with outstanding scenery and wildlife. I have found little evidence that the present numbers of visitors have significant impact on the vegetation. This is chiefly because they are actively discouraged from visiting many of the unsettled areas of the island. With planned management (for example, an extended network of marked walking tracks), many more tourists should be able to see more of the vegetation and wildlife with no increase in damage.

The palm seed industry is a major source of income to the Board for essential public works. I have discussed it elsewhere (Pickard, 1980) and will only restate here that the present levels of harvesting are not damaging the vegetation. Income from seeding should increase with a change from exploitative to conservative attitudes. Plantations and nurseries should be established. Even if plantations and/or a National Park were established, there is no ecological reason why both the traditional seed harvest and the more recent seedling harvest should not continue. After an establishment period of some 15 years (for *Howea forsterana*), plantations can be expected to supply sufficient seed for both nurseries and direct export. Similarly, other native plants could be grown in nurseries for export.

Much of the vegetation on Lord Howe does not occur in Australia, although similar types are found on other Pacific Islands. Therefore, in an Australian context, Lord Howe can be regarded as unique. This alone is sufficient justification for conservation. If one accepts the view that the best way to conserve species is to conserve their habitat, this provides further justification. Lord Howe has an endemic flora of some 60 vascular species and an unknown number of non-vascular species. About 20 of these endemics dominate the vegetation on some 860 ha (about 55 per cent of the island). Clearly, if we are to conserve this genetic diversity, we must conserve the vegetation.

Although the Environmental Survey recommended that a large proportion of the island be dedicated as National Park, this has not yet been done. The island has been nominated as one of ten areas in Australia warranting the status of World Heritage Areas, but at the time of writing (1981), acceptance of this by the New South Wales and Australian Governments was still awaited.

The prime responsibility of the Lord Howe Island Board at present is to look after the welfare of the residents. Under the same legislation the Board is required to manage the natural areas. However, the welfare of residents will always be the primary aim and frequently in conflict with conservation. There is no reason why the Board could not acquire the attitudes and skills necessary to manage the natural areas. But this would not diminish the conflict between the intangibles of conservation and the monetary value placed on welfare.

Dedication of these natural areas by the New South Wales Government as National Park carries a statutory requirement for expert conservation management. I believe that the correct action would be to create the National Park. The vegetation of Lord Howe has survived 140 years of settlement with relatively little damage. It would be regrettable if the information now available were not used to ensure its continued survival.

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This survey commenced in 1970 as part of the Environmental Survey of Lord Howe Island which was coordinated by Dr Harry F. Recher (The Australian Museum). Encouragement to participate in the Survey was given by Dr John S. Beard, then Director and Chief Botanist, Royal Botanic Gardens. Dr L.A.S. Johnson, Director, Royal Botanic Gardens, approved extension of the original survey as part of the Vegetation Survey of New South Wales.

Field work was supported by the Royal Botanic Gardens, the Lord Howe Island Board, The Australian Museum and the National Parks and Wildlife Service of New South Wales. I was assisted in the field by John Ewbank, Phillip Lindsay and with the site sampling by Dr Stephen S. Clark. So many island residents helped me in so many ways that to single out any one person is invidious as all offered unstinting friendship and help.

The botanists, particularly Anthony N. Rodd, at the National Herbarium, Royal Botanic Gardens, identified plants and Dr Surrey W.L. Jacobs played devil's advocate to some of my wilder ideas. Helen Bryant drew the block diagrams; Heidi Dlugaj photographed the diagrams and helped in many ways tidying up loose ends and details. The task of typing fell to Phyllis Phillips.

This paper is based on my Master of Science thesis "Vegetation of Lord Howe Island". My supervisor was Dr Peter J. Myerscough of the Botany Department, University of Sydney. The comments of Dr Len J. Webb (CSIRO Rainforest Ecology Section) and Dr D. Walker (Research School of Pacific Studies, The Australian National University) have stimulated considerable improvement in the structure and organization of the paper. Dr Jocelyn M. Powell (Royal Botanic Gardens) took on the immense task of critically editing the manuscript and preparing it for publication.

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CENSUS OF VASCULAR FLORA OF LORD HOWE ISLAND

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ABSTRACT

Rodd, A.N. and Pickard, John (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, New South Wales, Australia 2000) 1983. Census of vascular flora of Lord Howe Island. Cunninghamia 1(2): 267-280.* The native and naturalized vascular plants of Lord Howe Island (31°30′S, 159°05′E) are listed with authors, commonly-used synonyms and common names. Endemic taxa are noted. The total vascular flora of 379 species has 219 native, 74 endemic and 160 naturalized species; 33 previously recorded species have been deleted.

INTRODUCTION

This paper lists the vascular flora of Lord Howe Island (31°30′S, 159°05′E). The species are arranged in two groups: native and naturalized. Within each group there is the sequence Pteridophytes, Gymnosperms, Monocotyledons, Dicotyledons, but within each of these classes arrangement is alphabetical by families, genera and species. Synonyms are given if they have been used as valid names in publications going back as far as Oliver's (1917) account of the flora, but no earlier. We have made little attempt to resolve taxonomic problems and have not made any new combinations. In general, nomenclature follows Jacobs & Pickard (1981); the Pteridophytes have been reviewed by Dr Mary Tindale.

In the case of a number of species, difficulty has been encountered in deciding whether to give them native or naturalized status. The status given in Jacobs & Pickard (1981) has generally been taken as a reliable guide, but we have departed from it in a few cases in which we feel the status on Lord Howe is not necessarily the same as that on the mainland. The distinction is further blurred by the occurrence of recent natural invasions by a number of species, that is, without assistance from man. If these species are native in the region (Australia or New Zealand), they are regarded as native, but it would obviously be absurd to treat them as such if they are normally regarded as aliens in these countries. A full discussion of recent invasions of Lord Howe Island is in preparation by Pickard.

This account updates the species records given in Oliver (1917), Rodd (1974), and Jacobs & Pickard (1981). As might be expected, botanical taxonomy has advanced considerably and nomenclature has hence suffered many changes since Oliver's time, though his has hitherto remained the most comprehensive and informative account of the flora.

The list by Rodd covered Angiosperms only, and since 1974 quite a number of new records and nomenclatural changes have emerged. Even in Jacobs & Pickard's census of New South Wales plants (1981), in which one column throughout records occurrences on Lord Howe, a number of erroneous listings and omissions have shown up. This work likewise does not include Pteridophytes.

Oliver (1917), in a brief addendum, laid to rest a number of false records and inapplicable names published by earlier authors such as Moore, Mueller, Bentham, Tate and Hemsley, purportedly applying to Lord Howe Island plants, (for references see Pickard (1973)). This paper likewise has a section consisting of proposed deletions from the island's present-day flora. It is subdivided into four categories, representing respectively unverified records, short-lived invasions, native species now believed extinct, and known misidentifications.

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The handbook by Rodd (1981) includes a floristic list covering only native species. For these it gives a breakdown of geographic distribution by both genus and species for all taxa listed. The only previous accounts to attempt this were those of Hemsley (1896) and Oliver (1917), at species level only, and much phytogeographic and taxonomic data have accumulated since.

Common names are given in a separate alphabetical list, cross-referenced to the accepted botanical name. Only "island" names of native species are included.

Endemic status is shown by the symbol + preceding the name of a species. If the genus also is endemic, an additional + is shown, for example + + *Negria rhabdothamnoides.* For the very few species represented by an endemic variety or subspecies the symbol is inserted in front of the infraspecific epithet.

CENSUS OF VASCULAR FLORA

NATIVE SPECIES

PTERIDOPHYTES

Adiantaceae
Adiantum aethiopicum L.
A. hispidulum Sw. s. lat.
Cheilanthes distans (R.Br.) Mett. [Notholaena distans R.Br.]
Pellaea falcata (R.Br.) Fée

Aspidiaceae
+ *Lastreopsis nephrodioides* (Baker) Tindale [Dryopteris nephrodioides (Baker) Watts, D. apicalis (Baker) Kuntze]
+ *Polystichum moorei* (Christ) W.R.B. Oliver
+ *P. whiteleggei* Watts

Aspleniaceae
Asplenium australasicum (J.Sm.) Hook. [A. nidus auct. non L.]
+ *A. howeanum* (Watts) W.R.B. Oliver
A. milnei Carruth. ex Seemen [A. lucidum auct. non Forst. f., A. oblongifolium Colenso]
A. polyodon Forst. f. [A. adiantoides (L.) C.Chr.]
+ *A. pteridoides* Baker

Athyriaceae
+ *Diplazium melanochlamys* (Hook.) T. Moore

Blechnaceae
Blechnum sp. aff. *oceanicum* (Rosenstock) Brownlie [B. attenuatum auct. non (Sw.) Mett.]
B. sp. aff. *wattsii* Tindale [B. capense auct. non (L.) D.F.K. Schldl.]
+ *B. fullagari* (F. Muell.) C.Chr.
B. patersonii (R.Br.) Mett.
+ *Doodia caudata* (Cav.) R.Br.
D. media R.Br. subsp. australis Parris [D. aspera auct. non R.Br.]

Cyatheaceae
+ *Cyathea brevipinna* Baker [Alsophila brevipinna (Baker) R. Tryon]
+ *C. howeana* Domin [Hemitelia moorei Baker]
+ *C. macarthurii* (F. Muell.) Baker [Alsophila ferdinandii R. Tryon]
+ *C. robusta* (C. Moore) Holttum [Alsophila robusta C. Moore, Sphaeropteris robusta (C. Moore) R. Tryon]

Davalliaceae
Arthropteris tenella (Forst.f.) J. Smith
Nephrolepis cordifolia (L.) C. Presl

Dennstaedtiaceae
Histiopteris incisa (Thunb.) J. Smith
Hypolepis sp. [H. tenuifolia auct. non (Forst.f.) Bernh.]

Gleicheniaceae
Sticherus sp.

Grammitaceae
+*Grammitis diminuta* (Baker) Copel. [Polypodium diminutum Baker]
+*G. wattsii* Copel. [Polypodium pulchellum Watts]

Hymenophyllaceae
*Callistopteris baueriana** (Endl.) Copel. [Trichomanes baueranum Endl.]
Cephalomanes atrovirens C. Presl [Trichomanes javanicum auct. non Blume]
+*Hymenophyllum moorei* Baker [H. pumilum auct. non C. Moore]
H. multifidum (Forst. f.) Sw.

Lycopodiaceae
Lycopodium myrtifolium Forst. f. [L. varium R.Br., Huperzia varia (R.Br.) Trev. St. L¶eon, Urostachys myrtifolia (Forst.f.) Herter]

Marattiaceae
Marattia salicina Smith subsp. [M. fraxinea Smith var. howeana W.R.B. Oliver]

Ophioglossaceae
Botrychium australe R.Br.
Ophioglossum prantlii C. Chr. [O. vulgatum L. var. prantlii (C. Chr.) W.R.B. Oliver]

Osmundaceae
+*Leptopteris moorei* (Baker) Christ

Polypodiaceae
Microsorum scandens (Forst. f.) Tindale
+*M.* sp. aff. *diversifolium* (Willd.) Copel. [Polypodium diversifolium Willd. s. lat.]
Platycerium bifurcatum (Cav.) C.Chr.
Pyrrosia confluens (R.Br.) Ching [Cyclophorus confluens (R.Br.) C.Chr.]

Psilotaceae
Psilotum nudum (L.) Beauv. [P. triquetrum Sw.]
Tmesipteris truncata (R.Br.) Desv. [T. tannensis auct. non (Spreng.) Bernh].

Pteridaceae
Pteris microptera Mett. ex Kuhn [P. comans auct. non Forst.f.]
P. tremula R.Br.

Thelypteridaceae
Christella dentata (Forssk.) Brownsey & Jermy [Cyclosorus dentatus (Forssk.) Ching, Cyclosorus nymphalis (Forst.f.) Ching, Dryopteris parasitica auct. non (L.) Kuntze]

ANGIOSPERMS
MONOCOTYLEDONS

Amaryllidaceae
Crinum pedunculatum R.Br.

Arecaceae
+ +*Hedyscepe canterburyana* (C. Moore & F. Muell.) H. Wendl. & Drude
+ +*Howea belmoreana* (C. Moore & F. Muell.) Becc.
+ +*H. forsteriana* (C. Moore & F. Muell.) Becc.
+ +*Lepidorrhachis mooreana* (F. Muell.) O.F. Cook [Clinostigma mooreanum (F. Muell.) H. Wendl. & Drude]

Commelinaceae
Commelina cyanea R.Br.

Cyperaceae
Baumea juncea (R.Br.) Palla [Machaerina juncea (R.Br.) Koyama, Cladium junceum R.Br.]
Bulbostylis densa (Wall.) Hand.-Maz. [B. capillaris (L.) C.B. Clarke s. lat.]

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*Following a decision of the 13th International Botanical Congress in 1981 to modify the International Code of Botanical Nomenclature, epithets such as *bauerana* and *forsterana* have been altered to *baueriana* and *forsteriana* respectively.

Carex breviculmis R.Br.
C. hattoriana Nakai ex Tuyama [C. gracilis R.Br. non Curtis, C. brunnea Thunb., s. lat.]
C. pumila Thunb. [C. littorea Labill.]
Cyperus lucidus R.Br. [C. haematodes Endl., Mariscus haematodes (Endl.) Laing]
Gahnia xanthocarpa (Hook.f.) Hook.f.
+*Machaerina insularis* (Benth.) Koyama [Cladium insulare Benth.]
Scirpus nodosus Rottb.
Uncinia debilior F. Muell. [U. astonii Hamlin, U. filiformis Boott var. debilior (F. Muell.) W.R.B. Oliver, U. compacta R.Br. s. latiss.]

Flagellariaceae
Flagellaria indica L.

Iridaceae
+*Dietes robinsoniana* (C. Moore & F. Muell.) Klatt [Moraea robinsoniana C. Moore & F. Muell.]

Hydrocharitaceae
Halophila ovalis (R.Br.) Hook. f. subsp. *ovalis*

Juncaceae
Juncus pallidus R.Br.
+*Luzula longiflora* Benth. [L. campestris (L.) DC. s. latiss.]

Juncaginaceae
Triglochin striatum Ruiz & Pavon

Liliaceae
Dianella intermedia Endl. [D. caerulea Sims s. lat.]

Orchidaceae
Bulbophyllum tuberculatum Colenso [B. exiguum auct. non F. Muell.]
Dendrobium gracilicaule F. Muell. var. *howeanum* Maiden
+*D. moorei* F. Muell.
Microtis unifolia (Forst. f.) Reichb. f. [M. porrifolia (Sw.) R.Br., M. parvifolia R.Br.]
+*Plectorrhiza erecta* (Fitzg.) Dockrill [Cleisostoma erectum Fitzg.]
Pterostylis ?obtusa R.Br.
P. pedunculata R.Br.
P. sp.

Pandanaceae
+*Pandanus forsteri* C. Moore & F. Muell.

Philesiaceae
Geitonoplesium cymosum (R.Br.) A. Cunn. ex Hook.

Poaceae (Gramineae)
Agropyron scabrum (Labill.) Beauv. var. *scabrum*
Agrostis aemula R.Br.
+*Chionochloa* sp. aff. *conspicua* (Forst.f.) Zotov
Cynodon dactylon (L.) Pers.
Danthonia racemosa R.Br. var. *racemosa* [Notodanthonia racemosa (R.Br.) Zotov]
D. unarede Raoul [Notodanthonia unarede (Raoul) Zotov]
Dichelachne crinita (L.) Hook. f.
D. micrantha (Cav.) Domin [D. sciurea (R.Br.) Hook. f.]
Imperata cylindrica Beauv. var. *major* (Nees) Hubbard. [I. arundinacea Cyr.]
Oplismenus imbecillis (R.Br.) Roem. & Schult. [O. aemulus auct. non (R.Br.) Kunth]
Paspalum paspalodes (Michx.) Scribn. [P. distichum auct. non L.]
P. distichum L. [P. vaginatum Sw.]
Phragmites australis (Cav.) Trin. ex. Steud. [P. communis Trin.]
Poa poiformis (Labill.) Druce [P. australis R.Br. s. lat., P. caespitosa Spreng. s. latiss.]
Spinifex hirsutus Labill.
Sporobolus virginicus (L.) Kunth

Smilacaceae
Smilax australis R.Br.

Typhaceae
Typha sp. (*T. ?orientalis* C. Presl)

Zosteraceae
Zostera capricorni Aschers.

DICOTYLEDONS
Aizoaceae
Carpobrotus glaucescens (Haw.) Schwantes [Mesembryanthemum aequilaterale auct. non Haw.]
Sesuvium portulacastrum L.
Tetragonia tetragonioides (Pallas) Kuntze [T. expansa Murray]

Amaranthaceae
Achyranthes aspera L. var. *canescens* (R.Br.) Drake [A. canescens R.Br.]

Apiaceae (Umbelliferae)
Apium insulare P.S. Short
A. prostratum Labill. ex Vent. subsp. + *howense* P.S. Short.
A. sp. (aff. *A. insulare?)*
Hydrocotyle javanica Thunb. [H. hirta auct. non R.Br.]

Apocynaceae
+*Alyxia lindii* F. Muell.
A. ruscifolia R.Br.
+*A. squamulosa* C. Moore & F. Muell.
Ochrosia elliptica Labill. [Bleekeria elliptica (Labill.) Koidzumi]
Parsonsia straminea (R.Br.) F. Muell. var. + *glabrata* Pichon [Lyonsia reticulata auct. non F. Muell.]

Araliaceae
+*Polyscias cissodendron* (C. Moore & F. Muell.) Harms [Nothopanax cissodendron (C. Moore & F. Muell.) W.R.B. Oliver]

Asclepiadaceae
Marsdenia rostrata R.Br.
Tylophora biglandulosa (Endl.) A. Gray

Asteraceae
+*Brachycome segmentosa* C. Moore & F. Muell.
+*Cassinia tenuifolia* Benth.
Cotula australis (Sieber ex Spreng.) Hook. f.
Gnaphalium luteoalbum L. s. lat.
G. sp. aff. *sphaericum* Willd.
+ +*Lordhowea insularis* (Benth.) B. Nordenstam [Senecio insularis Benth.]
Melanthera biflora (L.) M. Wild [Wedelia biflora (L.) DC., W. uniflora (Spreng.) W.R.B. Oliver, Wollastonia biflora (L.) DC.]
+*Olearia ballii* (F. Muell.) Hemsl.
O. elliptica DC.
+*O. mooneyi* (F. Muell.) Hemsl.
Senecio sp. aff. *quadridentatus* Labill. [Erechtites quadridentata (Labill.) DC. s. lat.]

Avicenniaceae
Avicennia marina (Forsk.) Vierh. var. *australasica* (Walp.) Moldenke [A. officinalis L. s. lat.]

Bignoniaceae
Pandorea pandorana (Andr.) Steenis subsp. [P. austro-caledonica (Bur.) Seem.]

Brassicaceae (Cruciferae)
+*Lepidium howei-insulae* Thell.
L. oleraceum Forst. f. var. nov.?

Caesalpiniaceae
Caesalpinia bonduc (L.) Roxb. [C. bonducella (L.) Fleming, Guilandina bonduc L.]

Campanulaceae
Wahlenbergia gracilis (Forst.f.) Schrad.
+*W. insulae-howei* Lothian [W. limenophylax Lothian]

Celastraceae
Elaeodendron curtipendulum Endl.

Chenopodiaceae
Atriplex cinerea Poir.
Sarcocornia quinqueflora (Bunge ex Ungern-Sternberg) A.J. Scott [Salicornia quinqueflora Bunge ex Ungern-Sternberg, S. australis Sol. ex Benth.]

Convolvulaceae
Calystegia soldanella (L.) R.Br.
Ipomoea brasiliensis (L.) Sweet [I. pes-caprae (L.) R.Br. subsp. brasiliensis (L.) Ootstrom]
I. cairica (L.) Sweet

Crassulaceae
Crassula sieberiana (Schult.) Druce

Elaeocarpaceae
+ *Elaeocarpus costatus* M.R.F. Taylor

Epacridaceae
+ *Dracophyllum fitzgeraldii* C. Moore & F. Muell.
Leucopogon parviflorus (Andr.) Lindl. [L. richei (Labill.) R.Br.]

Escalloniaceae
+ *Corokia carpodetoides* (F. Muell.) L.S. Smith [Colmeiroa carpodetoides F. Muell.]

Euphorbiaceae
Baloghia lucida Endl.
Drypetes lasiogyna (F. Muell.) Pax & K. Hoffmann var. *australasica* (J. Muell.) Airy Shaw [D. australasica (J. Muell.) Pax & K. Hoffmann, Hemicyclia australasica J. Muell., D. affinis Pax & K. Hoffmann]
Euphorbia sparrmanii Boiss. [Chamaesyce sparrmanii (Boiss.) Hurusawa]
Omalanthus populifolius Grah.

Fabaceae (Papilionaceae)
Canavalia rosea (Sw.) DC. [C. maritima (Aubl.) Thou., C. obtusifolia (Lam.) DC.]
+ *Carmichaelia exsul* F. Muell.
Mucuna gigantea (Willd.) DC.
+ *Sophora howinsula* (W.R.B. Oliver) P.S. Green [S. tetraptera J. Mill. var. howinsula W.R.B. Oliver]
Vigna marina (Burm.) Merr. [V. lutea (Sw.) A. Gray]

Flacourtiaceae
Xylosma ovata Benth. [X. maidenii Sleumer]
+ *X.* sp. [X. ovata var. parvifolia F. Muell. ex Sleumer]

Gesneriaceae
+ + *Negria rhabdothamnoides* F. Muell.

Lamiaceae (Labiatae)
Westringia fruticosa (Willd.) Druce [W. rosmariniformis Sm.]

Lauraceae
+ *Cryptocarya gregsonii* Maiden
C. triplinervis R.Br.

Lobeliaceae
Lobelia alata Labill. [L. anceps auct. non L.f.]

Loganiaceae
+ *Geniostoma petiolosum* C. Moore & F. Muell.

Malvaceae
Hibiscus tiliaceus L. subsp. *tiliaceus*
Lagunaria patersonia (Andr.) G. Don

Meliaceae
+ *Dysoxylum pachyphyllum* Hemsl.

Menispermaceae
Stephania japonica (Thunb.) Miers var. *timoriensis* (DC.) Forman [S. forsteri (DC.) A. Gray]

Moraceae
+ *Ficus columnaris* C. Moore & F. Muell. [F. macrophylla Desf. ex Pers. s. lat.]
Malaisia scandens (Lour.) Planch.

Myoporaceae
Myoporum insulare R.Br.

Mysinaceae
Aegiceras corniculatum (L.) Blanco
+ *Rapanea mccomishii* Sprague
+ *R. myrtillina* Mez
+ *R. platystigma* (F. Muell.) Mez

Myrtaceae
+ *Cleistocalyx fullagari* (F. Muell.) Merr. & Perry [Acicalyptus fullagari F. Muell.]
Leptospermum flavescens Sm.
+ *Melaleuca howeana* Cheel [M. ericifolia auct. non Sm.]
+ *Metrosideros nervulosa* C. Moore & F. Muell.
+ M. sp. aff. *collina* (Forst. & Forst.f.) A. Gray [M. villosa auct. non Sm.]

Nyctaginaceae
Pisonia umbellifera (Forst. & Forst.f.) Seem. [P. brunoniana Endl., Heimerliodendron brunonianum (Endl.) Skottsb.]

Oleaceae
+ *Chionanthus quadristamineus* F. Muell. [Linociera quadristaminea (F. Muell.) Knobl., Notelaea quadristaminea (F. Muell.) Hemsl.]
Jasminum didymum Forst. f.
J. volubile Jacq. [J. simplicifolium auct. non Forst.f.]
Olea paniculata R.Br.

Onagraceae
Epilobium billardierianum Ser. subsp. *cinereum* (A. Rich.) Raven & Englehorn

Oxalidaceae
Oxalis rubens Haw. [O. corniculata L. s. lat.]

Passifloraceae
Passiflora herbertiana Ker subsp. + *insulae-howei* P.S. Green

Peperomiaceae
Peperomia tetraphylla (Forst. f.) Hook. & Arn.
P. urvilleana A. Rich.

Piperaceae
Macropiper excelsum (Forst.f.) Miq. var. *psittacorum* (Endl.) Laing [M. excelsum f.psittacorum (Endl.) A.C. Smith, M. excelsum var. majus (Cheeseman) Allan, Piper excelsum Forst.f. var. psittacorum (Endl.) C.DC.]

Pittosporaceae
+ *Pittosporum erioloma* C. Moore & F. Muell.

Plantaginaceae
+ *Plantago hedleyi* Maiden

Polygonaceae
Muehlenbeckia cf. M. complexa (A.Cunn.) Meisn. [M. axillaris auct. non (Hook.f.) Walp.]

Ranunculaceae
Clematis glycinoides DC.

Rubiaceae
+ *Coprosma lanceolaris* F. Muell.
+ *C. prisca* W.R.B. Oliver
+ *C. putida* C. Moore & F. Muell.
+ *Psychotria carronis* C. Moore & F. Muell.
+ *Randia stipulosa* C. Moore & F. Muell.

Rutaceae
Bauerella simplicifolia (Endl.) T.G. Hartley [Acronychia simplicifolia (Endl.) D.J. McGillivray & P.S. Green, A. baueri Schott]
+ *Euodia polybotrya* C. Moore & F. Muell.
+ *Melicope contermina* C. Moore & F. Muell.
Zanthoxylum pinnatum (Forst. & Forst.f.) Druce

Santalaceae
+ *Exocarpos homalocladus* C. Moore & F. Muell.

Sapindaceae
Dodonaea viscosa (L.) Jacq.
+*Guioa coriacea* (Radlk.) Radlk.

Sapotaceae
Planchonella myrsinoides (A. Cunn. ex Benth.) S.T. Blake ex Francis [Sideroxylon howeanum (F. Muell.) C. Moore & Betche]

Solanaceae
Nicotiana debneyi Domin
Solanum aviculare Forst.f.
S. nodiflorum Jacq. subsp. *nutans* R.J. Henderson [S. nigrum L. s. lat.]

Symplocaceae
+*Symplocos candelabrum* Brand [S. cochinchinensis (Lour.) S. Moore subsp. thwaitesii (F. Muell.) Nooteboom var. montana (C.T. White) Nooteboom s. lat., S. cochinchinensis subsp. thwaitesii var. stawelli (F. Muell.) Nooteboom s. lat.]

Thymelaeaceae
+*Pimelea congesta* C. Moore & F. Muell.

Ulmaceae
+*Celtis amblyphylla* F. Muell.

Urticaceae
+*Boehmeria calophleba* C. Moore & F. Muell.
Elatostema reticulatum Wedd. var. +*grande* Benth.
Parietaria debilis Forst.f.

Violaceae
Melicytus novae-zelandiae (A. Cunn.) P.S. Green subsp. + *centurionis* P.S. Green [Hymenanthera novae-zelandiae (A. Cunn.) Hemsl.]

Viscaceae
+*Korthalsella howensis* (Tiegh.) Engl. [K. japonica (Thunb.) Engl. s. lat.]
K. japonica (Thunb.) Engl. [K. articulata (Burm.f.) Tieghem]

Winteraceae
+*Bubbia howeana* (F. Muell.) Tieghem [Drimys howeana F. Muell.]

NATURALIZED NON-NATIVE SPECIES

PTERIDOPHYTES
Aspidiaceae
Cyrtomium falcatum (L.f.) Presl

GYMNOSPERMS
Araucariaceae
Araucaria heterophylla (Salisb.) Franco [A. excelsa R.Br.]

ANGIOSPERMS
MONOCOTYLEDONS
Alstroemeriaceae
Alstroemeria psittacina Lehm.

Araceae
Colocasia esculenta (L.) Schott

Commelinaceae
Tradescantia albiflora Kunth
Zebrina pendula Schnizl.

Cyperaceae
Carex inversa R.Br.
Cyperus brevifolius (Rottb.) Hassk. [Kyllinga monocephala auct. non Rottb.]
C. eragrostis Lam.
C. involucratus Rottb. [C. alternifolius L. s. lat.]
C. polystachyos Rottb.
C. rotundus L.

Iridaceae
Sisyrinchium micranthum Cav.

Juncaceae
Juncus bufonius L.

Liliaceae (s. lat.)
Asparagus asparagoides (L.) W.F.Wight
A. densiflorus (Kunth) Jessop [A. sprengeri Regel]
A. setaceus (Kunth) Jessop [A. plumosus Bak.]
Lilium formosanum A. Wallace [L. philippinese Bak. var. formosanum (Bak.) E.H. Wilson]

Poaceae (Gramineae)
Arundinaria sp.
Avena barbata Pott. ex Link
Axonopus affinis Chase
A. compressus (Swartz) Beauv.
Briza maxima L.
B. minor L.
Bromus diandrus Roth
B. unioloides Kunth
Catapodium rigidum (L.) Hubbard
Chloris gayana Kunth
Dactylis glomerata L.
Digitaria sanguinalis (L.) Scop. [Panicum sanguinale L.]
Echinochloa crus-galli (L.) Beauv.
Eleusine indica (L.) Gaertn.
Eragrostis cilianensis (All.) Lutati
Hordeum glaucum Steud.
Lagurus ovatus L.
Lolium loliaceum (Bory & Chaub.) Hand.-Maz. [L. rigidum Gaudin var. rottboellioides Heldr. ex Boiss.]
L. rigidum Gaudin
Lophochloa cristata (L.) Hylander [Koeleria phleoides (Vill.) Pers.]
Melinis minutiflorus P. Beauv.
Monerma cylindrica (Willd.) Coss. & Dur.
Paspalum dilatatum Poir.
Pennisetum clandestinum Hochst. ex Chiov.
Phalaris aquatica L. [P. tuberosa auct. non L.]
P. canariensis L.
Poa annua L.
Polypogon monspeliensis (L.) Desf.
Rottboellia exaltata (L.) L.f.
Setaria palmifolia (Koenig) Stapf
Sporobolus africanus (Poir.) Robyns & Tournay [S. indicus auct. non R.Br.]
Stenotaphrum secundatum (Walt.) Kuntze [S. americanum Schrank]
Stipa ramosissima Trin.

DICOTYLEDONS
Amaranthaceae
Amaranthus viridis L.

Apiaceae (Umbelliferae)
Apium leptophyllum (Pers.) F. Muell.
Hydrocotyle bonariensis Lam.
Torilis nodosa (L.) Gaertn.

Apocynaceae
Vinca major L.

Araliaceae
Tetrapanax papyrifer (Hook.) K. Koch

Asteraceae (Compositae)
Ageratum conyzoides L.
Aster subulatus Michx.
Bidens pilosa L.
Centaurea melitensis L.
Chrysanthemoides monilifera (L.) T. Norlindh subsp. *rotundata* (DC.) T. Norlindh
Cirsium vulgare (Savi) Ten.
Conyza albida Willd. ex Spreng. [C. floribunda auct. non Kunth]
C. bonariensis (L.) Cronquist [Erigeron linifolium Willd.]

C. parva Cronquist [C. canadensis auct. non (L.) Cronquist]
Eupatorium adenophorum Spreng. [Ageratina adenophora (Spreng.) R.M. King & H. Robinson]
Gaillardia x *grandiflora* Houte
Galinsoga parviflora Cav.
Gnaphalium americanum Mill. [G. japonicum Thunb. s. lat.]
G. spicatum Lam.
Hypochoeris radicata L.
Lactuca saligna L.
Senecio elegans L. [S. ?vulgaris sensu Oliver]
S. petasitis DC.
Sonchus asper (L.) Hill subsp. *glaucescens* (Jordan) Ball ['Embergeria sp.' sensu Rodd (1974)]
S. oleraceus L.
Taraxacum officinale Weber [T. dens-leonis Benth. & F. Muell.]

Basellaceae
Anredera cordifolia (Ten.) Steenis

Brassicaceae (Cruciferae)
Cakile edentula (Bigel.) Hook. subsp. *edentula* [C. edentula subsp. californica (Heller) Hulten, C. maritima Scop. s. lat.]
Capsella bursa-pastoris (L.) Medik.
Coronopus didymus (L.) Sm.
Lepidium hyssopifolium Desv.
Lobularia maritima (L.) Desv.

Caesalpiniaceae
Cassia coluteoides Colladon [C. bicapsularis L. s. lat.]
C. floribunda Cav. [C. laevigata Willd.]

Caryophyllaceae
Arenaria serpyllifolia L.
Cerastium fontanum Baumg. subsp. *trivialis* (Link) Jalas
C. glomeratum Thuill. [C. vulgatum L. s. lat.]
Polycarpon tetraphyllum (L.) L.
Sagina apetala Ard.
Silene gallica L.
Stellaria media (L.) Vill.

Chenopodiaceae
Atriplex hastata L.
Chenopodium murale L.

Crassulaceae
Kalanchoe pinnata (Lam.) Pers.

Euphorbiaceae
Euphorbia heterophylla L.
E. peplus L.
E. prostrata Ait.
Phyllanthus tenellus Roxb.
Ricinus communis L.

Fabaceae (Papilionaceae)
Erythrina x *sykesii* Barneby & Krukoff [E. lysistemon sensu Rodd (1974)]
Lathyrus latifolius L.
Medicago lupulina L.
M. polymorpha L. var. *vulgaris* (Benth.) Shinners [M. denticulata Willd.]
Melilotus indica (L.) All.
Trifolium glomeratum L.
T. repens L.
Vicia sativa L. subsp. *angustifolia* (L.) Gaudich.

Fumariaceae
Fumaria muralis Sond. ex Koch subsp. *muralis*

Gentianaceae
Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch

Geraniaceae
Geranium molle L.

Lamiaceae (Labiatae)
Salvia coccinea Juss. ex J. Murr.
Stachys arvensis (L.) L.

Lauraceae
Cinnamomum camphora (L.) Nees

Malvaceae
Hibiscus mutabilis L.
Malva parviflora L.
Malvastrum coromandelianum (L.) Garcke
Modiola caroliniana (L.) G. Don
Sida rhombifolia L. subsp. *?retusa* (L.) Borss.

Moraceae
Morus alba L.

Myrtaceae
Psidium cattleianum Sabine
P. guajava L.

Ochnaceae
Ochna serrulata (Hoschst.) Walp.

Oleaceae
Ligustrum sinense Lour.
Olea europaea L. subsp. *africana* (Mill.) P.S. Green

Onagraceae
Oenothera drummondii Hook.

Oxalidaceae
Oxalis corniculata L. s. str.
O. corymbosa DC.

Passifloraceae
Passiflora edulis Sims

Pittosporaceae
Pittosporum undulatum Vent.

Plantaginaceae
Plantago lanceolata L.
P. major L.

Polygonaceae
Rumex brownii Campd.
R. crispus L.

Portulacaceae
Portulaca oleracea L.

Primulaceae
Anagallis arvensis L.

Proteaceae
Grevillea robusta A. Cunn.

Punicaceae
Punica granatum (L.) L.

Ranunculaceae
Ranunculus parviflorus L.

Rosaceae
Cotoneaster glaucophyllus Franch.
Duchesnea indica (Andr.) Focke
Eriobotrya japonica (Thunb.) Lindl.
Prunus persica (L.) Batsch

Rubiaceae
Coffea arabica L.

Rutaceae
Citrus limonia Osb. [incl. C. jambhiri Lushington]

Scrophulariaceae
Verbascum virgatum Stokes
Veronica arvensis L.

Solanaceae
Datura stramonium L.
Lycium ferocissimum Miers
Petunia x *hybrida* Vilm.
Physalis ixocarpa Brot.
P. peruviana L.
Solanum mauritianum Scop.
S. nigrum L. subsp. *nigrum*

Sterculiaceae
Brachychiton acerifolius F. Muell.

Valerianaceae
Centranthus ruber (L.) DC.

Verbenaceae
Lantana camara L.
Verbena bonariensis L.

DELETIONS FROM PRESENT-DAY FLORA OF LORD HOWE ISLAND

(1) Species recorded in previous accounts of the flora and accepted by Oliver (1917), but no specimens seen by Rodd or Pickard, and not recollected in recent years. In this group it is in most cases difficult, without seeing specimens, to distinguish between probable misidentifications and true records of species which have since disappeared from the island.

Hymenophyllum flabellatum Labill.
H. minimum A. Rich
H. tunbridgense (L.) Sm.
Pteridium esculentum (Forst. f.) Cockayne [P. aquilinum (L.) Kuhn var. esculentum (Forst. f.) Hook. f.]
Selaginella uliginosa (Labill.) Spring
Boerhavia repens L.
Cynanchum carnosum (R. Br.) Domin [Vincetoxicum carnosum (R. Br.) Benth.]
Disphyma australis (Ait.) J.M. Black [Mesembryanthemum australe Ait.]
Plectranthus parviflorus Willd.
Pseuderanthemum grandiflorum (Benth.) Domin [Eranthemum variabile R. Br. var. grandiflorum Benth.] (specimen in Kew Herbarium P.S. Green, pers. comm.)
Rhagodia baccata (Labil.) Moq.
Scaevola sericea Vahl [S. frutescens auct. non (Mill.) Krauss]
Sicyos australis Endl. [S. angulata auct. non L.] (specimen in Kew Herbarium P.S. Green, pers. comm.)
Tetragonia ? implexicoma Hook. f. [T. strongylocarpa (Endl.) W.R.B. Oliver]

(2) Species represented in National Herbarium of N.S.W. by one or two specimens only, and not recollected in recent years (1969—): mainly weedy exotics or Australian species which appear to have established briefly but have since died out.

Agrostis gigantea Roth
Avena sativa L.
Centaurea melitensis L.
Euphorbia thymifolia L.
Ipomoea alba L. [I. grandiflora Lam.]
Mirabilis jalapa L.
Nothoscordum inodorum (Ait.) Nicholson
Pelargonium australe Willd.
Plectranthus graveolens R.Br.
Pratia purpurascens (R.Br.) E. Wimmer
Urtica incisa Poir.
U. urens L.

(3) Species believed to have been part of the island's original flora, but regarded as now extinct.

Calystegia affinis Endl. [C. marginata R.Br. s. lat.]
Hibiscus diversifolius Jacq.
Pandanus pedunculatus R.Br. (only known plant died in 1975)
Pseuderanthemum grandiflorum—see also under (1)
Solanum bauerianum Endl. (believed extinct also on Norfolk Island, hence totally extinct)

(4) Species records based on known misidentifications.

Daucus glochidiatus (Labill.) Fisch., Mey. & Lall. [redet. as *Torilis nodosa* (L.) Gaertn.]
Ranunculus sessiliflorus R.Br. ex DC. [redet. as *R. parviflorus* L.]

COMMON NAMES

The following is an alphabetical list of local island names for indigenous species, with their botanical names.

Axe-handle Wood	*Planchonella myrsinoides*
Banyan	*Ficus columnaris*
Beach Lily	*Crinum pedunculatum*
Berrywood	*Ochrosia elliptica*
Big Mountain Palm	*Hedyscepe canterburyana*
Black Grape	*Psychotria carronis*
Blackbutt	*Cryptocarya triplinervis*
Bloodwood	*Baloghia lucida*
Blue Plum	*Chionanthus quadristamineus*
Bush Cane	*Flagellaria indica*
Bush Orchid	*Dendrobium gracilicaule*
Cedar	*Guioa coriacea*
Christmas Bush	*Alyxia ruscifolia*
Cottonwood	*Celtis amblyphylla*
Curly Palm	*Howea belmoreana*
Cut-grass	*Cyperus lucidus*
Cut-grass	*Gahnia xanthocarpa*
Dogwood	*Omalanthus populifolius*
Fitzgeraldi	*Dracophyllum fitzgeraldii*
Forked Tree	*Pandanus forsteri*
Goatwood	*Coprosma prisca*
Green Plum	*Randia stipulosa*
Greybark	*Drypetes lasiogyna* var. *australasica*
Hopwood	*Dodonaea viscosa*
Hotbark	*Bubbia howeana*
Island Apple	*Dysoxylum pachyphyllum*
Juniper	*Myoporum insulare*
Kava	*Macropiper excelsum* var. *psittacorum*
Kentia Palm	*Howea forsteriana*
Killmoke (or Killmug)	*Cassinia tenuifolia*
Lignum-vitae	*Sophora howinsula*
Little Mountain Palm	*Lepidorrhachis mooreana*
Mangrove	*Avicennia marina* var. *australasica*
Maulwood	*Olea paniculata*
Moorei	*Lepidorrhachis mooreana*
Mountain Daisy	*Olearia ballii*
Mountain Rose	*Metrosideros nervulosa*
Mountain Rose, Yellow	*Metrosideros* sp. aff. *collina*
Native Grass	*Carex hattoriana*
Pine	*Polyscias cissodendron*
Pumpkin Bush	*Olearia mooneyi*
Pumpkin Tree	*Negria rhabdothamnoides*
Punkwood	*Pisonia umbellifera*
Sallywood	*Lagunaria patersonia*
Scalybark	*Cleistocalyx fullagari*
Scurvey-weed	*Commelina cyanea*
Stinkwood	*Coprosma putida*
Tamana	*Elaeodendron curtipendulum*
Tea Tree	*Leptospermum flavescens*
Tea Tree	*Melaleuca howeana*

Thatch Palm	*Howea forsteriana*
Wedding Flower	*Solanum bauerianum*
Wedding Lily	*Dietes robinsoniana*
Yellow Mountain Rose	*Metrosideros* sp. aff. *collina*
Yellow-wood	*Zanthoxylum pinnatum*

ACKNOWLEDGMENTS

The assistance of Dr Mary Tindale is gratefully acknowledged, for checking the names of all Pteridophyte entries. Other botanists at the National Herbarium of New South Wales also gave valuable assistance in matters of identification and nomenclature.

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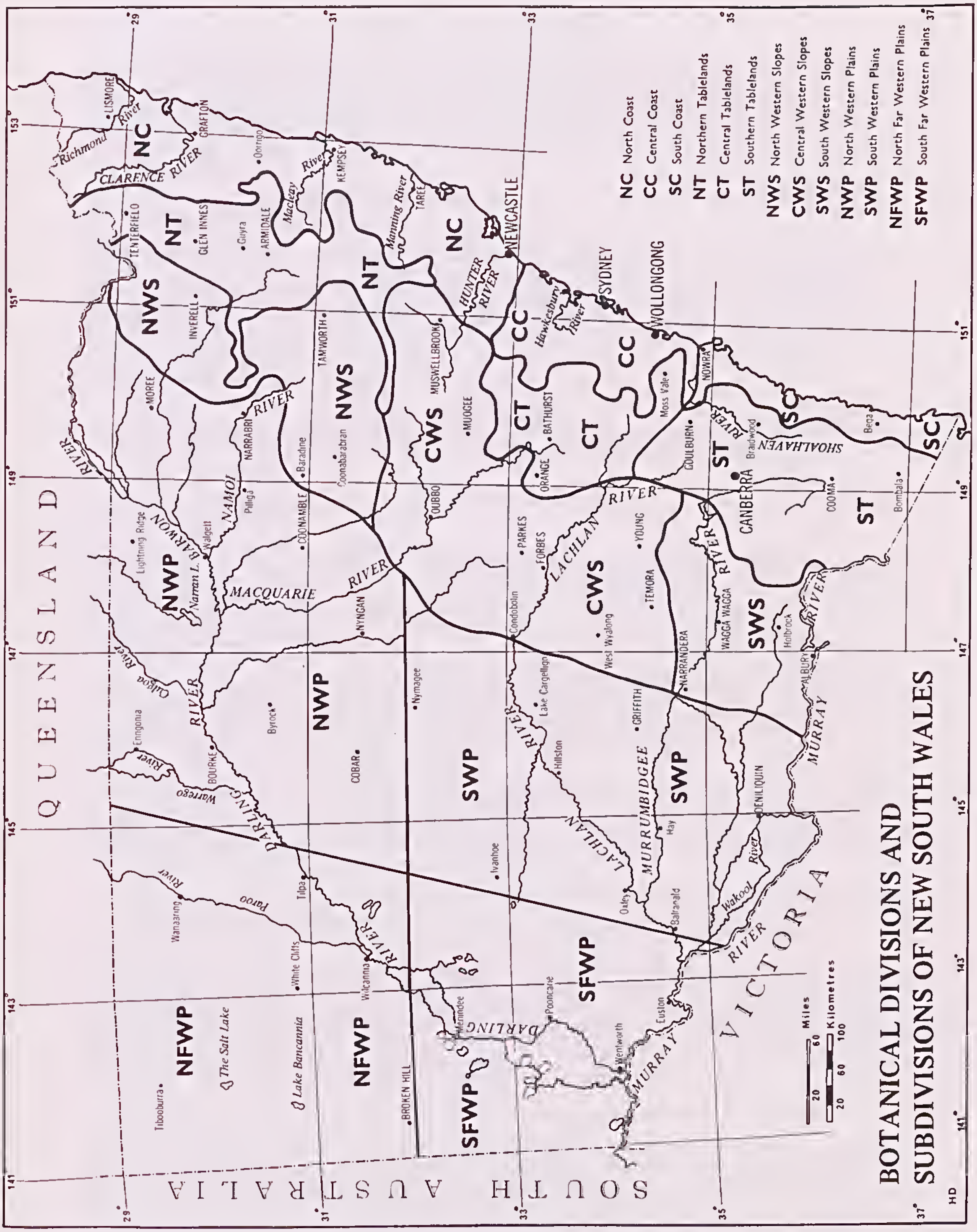

For explanation and description of the Botanical Divisions and Subdivisions of New South Wales see Anderson, R. H. (1961). Introduction. *Contr. New South Wales Natl. Herb. Fl. New South Wales* Nos 1–18, pp. 1–15.

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There is a range of different headings; the main headings should be centred, lesser ones placed at the left-hand margin. It would be helpful if authors could indicate in the margin the relative importance of a heading by use of ringed capital letters, e.g. (A) for main headings, (B) for secondary headings and (C) for tertiary headings, etc.

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Abbreviations and units. SI units (metre, kilogram etc.) are to be used. Statistics and measurements should always be given in figures, e.g. 10 mm, except where the number begins the sentence. When the number does not refer to a unit of measurement, it is spelt out where the number is less than 10. The Printing Style Manual, New South Wales Government Printing Office, or the annotated CSIRO Style Guide (both available at the National Herbarium of New South Wales) should be consulted for spelling, abbreviations and other conventions.

Tables. The presentation of the same data in both graphical and tabular form should be avoided. Tables must be clearly headed and, if possible, self-explanatory. They must be typed on separate sheets and should be numbered consecutively with arabic numerals. Column headings should be brief with units of measurements in parentheses. Each table must be referred to in the text and its approximate position should be indicated in the margin of the manuscript.

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VEGETATION MAP
OF
LORD HOWE ISLAND

BY JOHN PICKARD
NATIONAL HERBARIUM OF NEW SOUTH WALES

1000 500 0 500 1000
METRES METRES

1: 15840

CONTROL:

Mean value for P.M. "Flagstaff" derived from observations at Transit Hill by Mr. W.J. Conder, of the Trigonometrical Survey of N.S.W. in November 1882 and observations by Mr. Surveyor. Richmond near Signal Point in 1938 – Longitude referred to Sydney Observatory, 151° 12' 12·30" E.

For triangulation of Lord Howe Island see plans L.H.I. 13R and L.H.I. 86R

AREA:

Area of Lord Howe Island is 5 square miles.

COMPILATION:

Compiled and drawn by the Central Mapping Authority Department of Lands, N.S.W. from aerial photographs taken in April 1966

PROJECTION:

Universal Transverse Mercator

GRID:

The grid shown on face of this map is in 1,000 yards with values measured from the false origin of Zone 57 being 500,000 metres west and 10,000,000 metres south of the true origin at Longitude 159° E. and Latitude 0°.

Conversion factor 1 yard = 0·9144 metres exactly.

ELEVATION:

Elevations in feet. Standard Datum, Mean Sea Level, Sydney

Building
School, Post Office ,Church S PO +
Licensed guest house "Somerset"
Dwelling with wireless receiver, transmitter W/R W/T
Quarry
Minor horizontal control point ○ Transit Hill
Permanent mark FLAGSTAFF
Observation Station, Astronomical Station △ ⊕
Spot height approximate • 928
Reserves, Dedications
Watercourse, Watercourse Indefinite
Shoreline, Shoreline Indefinite
Anchorage, Jetty
Slipway
Rocks
Coral Reef, Underwater rock shelf
Rock, bare or awash *
Sand
Contours 500
Auxilary contour 25
Approximate contours 500
Cliffs (with relative height) 110r
Low cliff or steep bank (with relative height) 16r
Dense timber
Scattered timber

For details of portion numbers, leases and permissive occupancies refer to the Topographic Map of Lord Howe Island 6th edition

Basemap supplied by courtesy of Central Mapping Authority New South Wales

CROWN COPYRIGHT RESERVED

Contour interval 50 feet

Date of map: Preliminary edition 10th June 1971 with subsequent minor corrections. Revised 10th December 1977, May 1981.

Compiled and mapped by John Pickard, National Herbarium of New South Wales, as part of the Vegetation Survey of New South Wales.

Field sampling and checking August-September 1970, February-March 1971, May 1971, April-May 1972, November-December 1975, and February-March 1977.

Cartography by John Pickard, Heidi Dlugaj, Helen Bryant, and Forestry Commission of New South Wales.

Field work supported by the New South Wales Department of Agriculture, Lord Howe Island Board and The Australian Museum.

NOMENCLATURE: The structural system of Formations and Subformations is based on the Fosberg /IBP System (Fosberg, F.R. (1967) - A classification of vegetation for general purposes. In G.F. Peterken (ed.) *Guide to the checklist for IBP areas*. International Biological Program Handbook 4 : 73 - 120.)

CLOSED FOREST

RAIN FOREST

DRYPETES-CRYPTOCARYA

DaCt *Drypetes australasica-Cryptocarya triplinervis*
DaCtX *expased variant*
DaCtC *calcarenite variant*

CLEISTOCALYX- CHIONANTHUS

Cf *Cleistocalyx fullageri*
Cq *Chionanthus quadristamineus*
LM *Lowland Mixed Forest*

CRYPTOCARYA GREGSONII

Cg *Cryptocarya gregsonii*
The large area east of Tableland is Open Forest but is mapped here because landslides appear to have disturbed the stand

BROAD ORTHOPHYLL SWAMP FOREST

LAGUNARIA

Lagunaria patersonia

MEGAPHYLLOUS BROAD SCLEROPHYLL FOREST

HOWEA

Hf *Hawea forsterana*
Hb *Howea belmoreana*

HEDYSCEPE

Hc *Hedyscepe canterburyana*

PANDANUS

Pandanus forsteri

GNARLED MOSSY FOREST

BUBBIA-DRACOPHYLLUM

Bubbia howeana-Dracophyllum fitzgeraldii

CLOSED SCRUB

BROAD ORTHOPHYLL SCRUB

BOEHMERIA–MACROPIPER

BcMep *Boehmeria calaphleba- Macropiper excelsum var. psittacorum*

BROAD SCLEROPHYLL SWAMP SCRUB

AEGICERAS

Ac *Aegiceras carniculatum*

NARROW SCLEROPHYLL SCRUB

MELALEUCA-CASSINIA

Mh *Meloleuca howeono*
Ca *Cassinia tenuifolia*

BROAD SCLEROPHYLL SCRUB

DODONAEA

Dv *Dadanaea viscosa*

DRACOPHYLLUM-METROSIDEROS

Df Mn *Dracaphyllum fitzgeraldii-Metrosideros nervulosa*

DWARF SCRUB

ORTHOPHYLL DWARF SCRUB

ATRIPLEX

Ax *Atriplex cinerea*

OPEN SCRUB

BROAD SCLEROPHYLL SWAMP SCRUB

AVICENNIA

Ama *Avicennia marina var. australasica*

BROAD-LEAFED HERB VEGETATION

IPOMOEA–CARPOBROTUS

IcCg *Ipomoea cairica-Carpabrotus glaucescens*

MIXED FERN AND HERB

MFH Mixed fern and herb

TALL GRASS

SCLEROPHYLL TALL GRASS

CYPERUS

Cl *Cyperus lucidus*

SHORT GRASS

ORTHOPHYLL SHORT GRASS

POA

Pp *Poa poiformis*

CLOSED AND OPEN SUBMERGED MEADOW

SUBMERGED MEADOW

ZOSTERA-HALOPHILA

☐ *Zastera capricorni-Halophila ovalis*
Occurs in patches on lagoon floor but not mapped because the distribution is in sufficiently known

DISTURBED AREAS

Canopy more-or-less intact understory disturbed
Canopy and understory destroyed

PHYSIOGRAPHIC UNITS

Cliffs
Coral sand and beach
Basalt boulder beach
Calcarenite and coral boulder beach

BOUNDARIES

——— Boundary
- - - - - Boundary up to 100m wide

RELIABILITY DIAGRAM

A_2 A_2 Detailed mapping: air photo interpretation and numerous ground traverses
C_2 C_2 Reconnaissance mapping : air photo interpretation with few or no ground traverses
Air photo coverage
Cloud and shadow on air photos

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Census of vascular flora of Lord Howe Island **A.N. Rodd and John Pickard** 269

Map of Botanical Divisions and Subdivisions of New South Wales 281

Notice to Contributors 283

Lord Howe Island Long.^{de} 159-7-30 E = Lat.^{de} 31-32-49. S. as it app
Discover'd in 1788. by Lieut. H. L. Ball, Maste